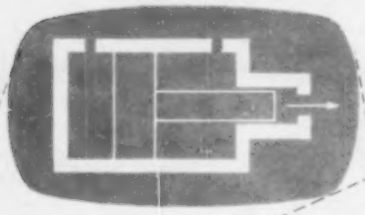
Applied Hydraulics

PNEUMATICS · ELECTRICAL CONTROLS

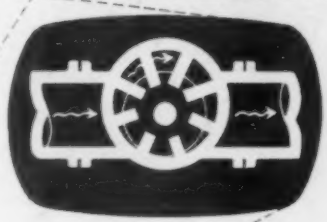
APRIL 1958

BOOSTERS



PUMPS

COMPRESSORS



ACCUMULATORS

A GUIDE TO PRESSURE GENERATORS

STEVENS RICE
UNIVERSITY MICROFILMS
515 N. FIRST ST.
ANN ARBOR MICH
AIJ9

THE MAGAZINE OF FLUID POWER

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

Meet With APPLIED HYDRAULICS' Editors

Booth 541

Design Engineering Show, Chicago, April 14-17

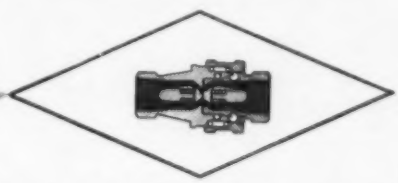
Wherever 2-way shut-off is required . . .

HERE'S THE COUPLING FOR THE JOB

HANSEN

SERIES HK®

TWO-WAY SHUT-OFF COUPLING

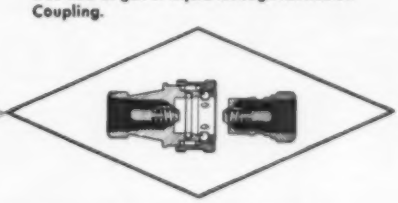


QUICK-CONNECTION *with* INSTANT AUTOMATIC FLOW

To connect Coupling, merely pull back sleeve, push Plug into Socket.

Blue section shows how torpedo type valves open in both Socket and Plug to permit free flow of gas or liquid through connected Coupling.

shuts off both sides of line . . . prevents loss of liquid, gas, or pressure



QUICK-DISCONNECTION *with* INSTANT AUTOMATIC SHUT-OFF

To disconnect Coupling, just pull back sleeve on Socket. No tools required.

Blue section shows how torpedo type valves contact valve seats in both Socket and Plug to provide instant seal of fluid in both ends of line.

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for L. P. Gas, Steam, Oxygen, Acetylene, etc.

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminate spilling of liquid or escape of gas at instant of disconnection.

Hansen Series HK Two-Way Shut-Off Couplings are available with female pipe thread connections from ⅛" to 1" inclusive. Available in brass or steel.

REPRESENTATIVES IN PRINCIPAL CITIES

SINCE 1915

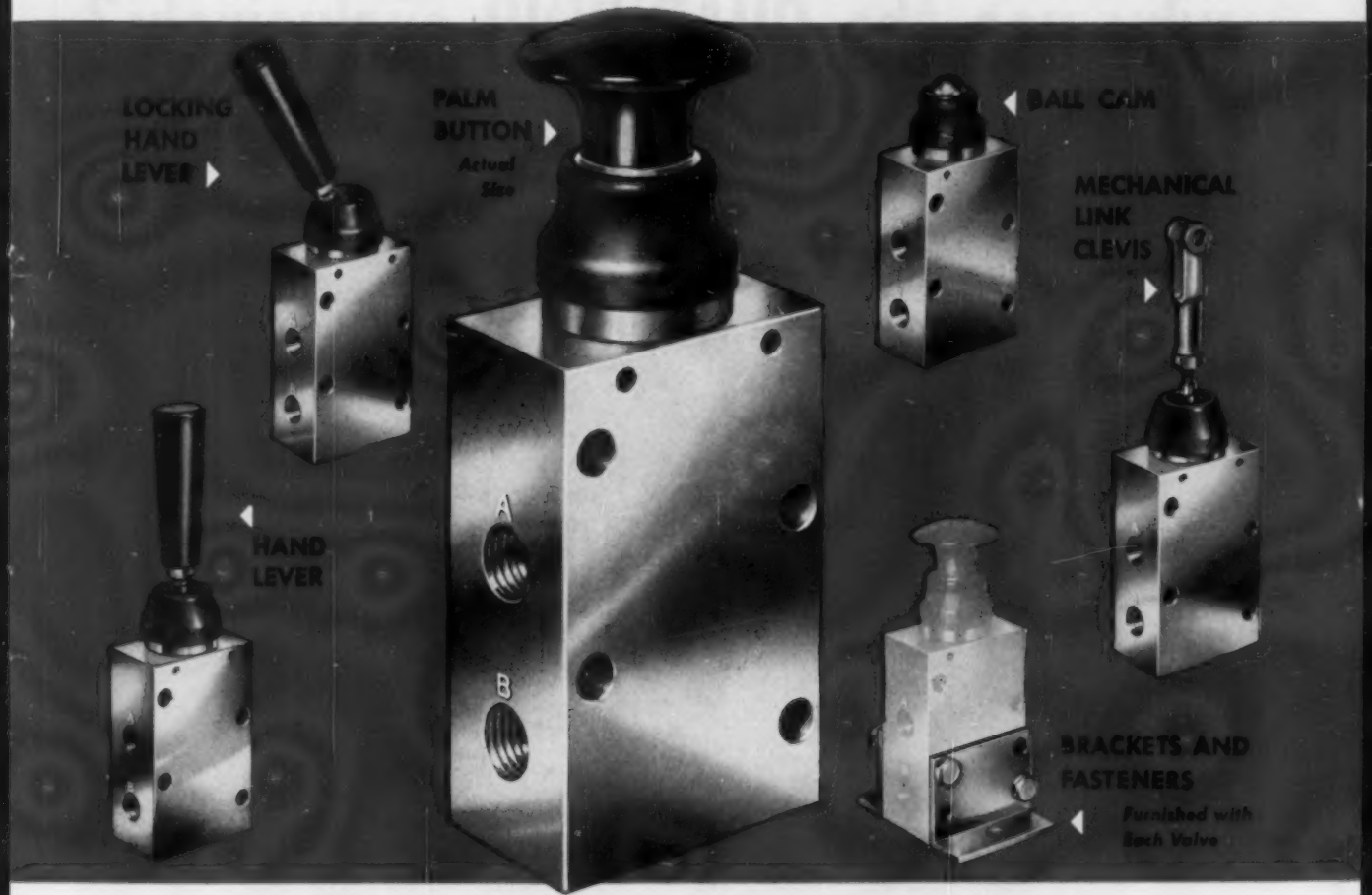
QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

CIRCLE 62 ON READER SERVICE CARD

NEW HANNA FLO-PILOT VALVE has dirt-proof seal!



Hanna Flo-Pilot Valves are ¼" two- and three-way Pilot Valves for air operation to 150 psi. They are used for remote control of master valves, directional control of small single acting cylinders and for shut-off. Same valve can be used for two or three-way operation either normally open or normally closed to inlet pressure.

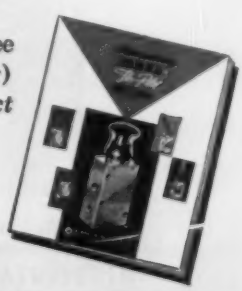
HANNA Flo-Pilot Valves will deliver years of dependable performance at a very low cost because they have built-in money-saving features. Every Hanna Flo-Pilot Valve is equipped with a synthetic boot which seals the valve stem and internal parts from harmful dirt and abrasive, thereby eliminating the most common cause of valve failure.

These protective boots, efficient "O" ring spool packing and nylon sleeves, are built into every Hanna Flo-Pilot Valve to save you money and assure leak-free operation even after millions of cycles.

The five actuating-heads—push button, ball cam, hand lever, locking hand lever and mechanical link clevis—are interchangeable in a matter of seconds. Spools can be changed just as quickly without disturbing the piping.

Corrosion resistant materials are used throughout. Flo-Pilot Valves have a simple, sturdy construction with anodized aluminum body, stainless steel and molded nylon parts. Valves can be conveniently mounted in any position and are furnished with brackets and fasteners. They are easy to operate, positive acting and have full capacity of ¼" orifices.

Ask your Hanna representative (see the yellow pages or Thomas Register) for complete information or *write direct for Catalog 262.*



Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES

1741 Elston Avenue • Chicago 22, Illinois

CIRCLE 60 ON READER SERVICE CARD

why use the QUAD® RING exclusively?

because it

"... withstands more wear"
"... maintains bubble-tight seal"
"... has high dependability rate"

100% Conversion to Quad Ring

Read the Chemtrol Corporation's explanation for their recent complete conversion from standard O-rings to the exclusive Minnesota Rubber QUAD RING.

CHEMTROL CORPORATION

October 18, 1957

chemtrol

1417 West El Segundo Blvd.
Compton - California
NEvada 6-5102

Minnesota Rubber & Gasket Company
18633 Ventura Boulevard
Tarzana, California

Gentlemen:

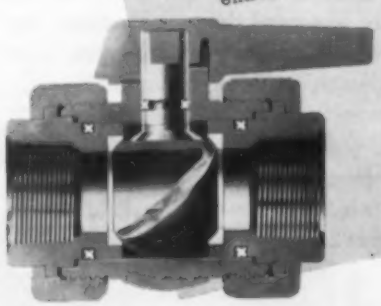
We have been utilizing your "Quad" ring design seals in our Micro-Meter Needle Valves, Micro-Flow Globe Valves and our line of Ball Valves in sizes from ¼" to 3" pipe size and have recently replaced all "O" ring seals with your "Quad" ring seals. Our reason for conversion to 100% "Quad" rings was based on many factors. The most important factor is the ability of the "Quad" ring type seals to maintain a bubble-tight seal ranging from high vacuum to our maximum pressures which in tests extend in a range to over 3000 psi. It has been our experience that the "Quad" ring seal, due to its' unique contact arrangement, has the ability to withstand more wear with less degradation than any other type of seal such as our standard 150,000 cycle wear test at elevated temperatures which we use to qualify our valve design. A very important factor in our utilization of Minnesota Rubber "Quad" rings is the unusually high dependability rate evidenced in the small amount of reject parts received which pays off in labor costs of replacement of defective seals after production testing.

We wish to further express our appreciation of the fine service extended us by your engineers, both in promptness of supply, engineering assistance and in addition, the cooperation of your laboratory in supplying us with data and special components that enable us to better serve our customers.

Yours very truly,
CHEMTROL CORPORATION

Martin Usab

Martin Usab, President



One member of the Minnesota Rubber family is the Research and Development Division. If your company has a problem in rubber, as Chemtrol did, you may find the answer in the excellent research facilities and programs of Minnesota Rubber's Research and Development Division.

16-page facilities brochure available on request. For full information, write:

MINNESOTA RUBBER COMPANY Dept. 104
3630 Wooddale Ave., Minneapolis 16, Minnesota

for color in rubber
for parts of silicone rubber
for versatility in rubber
for applied product development

MINNESOTA RUBBER

Rainbow Rubber Division
Silicone Rubber Division
Plastics & Latex Division
Research and Development Division

CIRCLE 95 ON READER SERVICE CARD

Applied Hydraulics

VOLUME 11/NUMBER 4

APRIL 1958 THE MAGAZINE OF FLUID POWER

SPECIAL REPORT

ALONG THE AISLES 32

POWER SOURCES FOR FLUID POWER SYSTEMS 77

PUMPS

HYDRAULIC PUMP SELECTION 79

CLOSE-COUPLED PUMP-MOTOR 94
By James A. Morrison

COMPARING PUMP POWER REQUIREMENTS 100
By Sanford Ellis

TAKE THE EASY STEP TO 2000 PSI HYDRAULICS 104

MATCHING PUMPS TO FREQUENCY RESPONSE 106
By Paul E. Straight

HOW TO TEST LOW VOLTAGE MOTOR-PUMPS 114
By G. F. Young

THE CASE FOR KCM PUMP RATINGS 122
By R. W. Johns

ACCUMULATORS

DESIGNING WITH GAS-OIL ACCUMULATORS 89

ACCUMULATOR GIVES FAST RESPONSE AND LOW POWER 118
By Lester Myers and Don Thomas

COMPRESSORS

AIR COMPRESSOR SELECTION 85

BOOSTERS

BOOSTERS—WHAT ARE THEY? WHAT CAN THEY DO? 90

HIGH FORCE PUNCH 92

EMERGENCY POWER SOURCE 93

TWO-PRESSURE BOOSTERS GIVE FAST PRESSURE CYCLING 110
By Rex C. Burnham and W. F. Dickinson

AVIATION SECTION

SPECIAL REPORT—POWER UNITS FOR AIRCRAFT AND MISSILES

AIRCRAFT HYDRAULIC PUMPS 126

AIRBORNE COMPRESSORS 130

DEPARTMENTS

6....Fluid Power Lines
13....Letters to the Editor
26....Future Events
50....Briefs
68....Useful Literature
74....New Products
160....Post Scripts of Industry
166....Market Place
167....Advertisers' Index

FRANCHISE CIRCULATION DISTILLED WRITING

copyright 1958 by The Industrial Publishing Corporation

BPA

For highest quality
when the pressure's on . . . it's

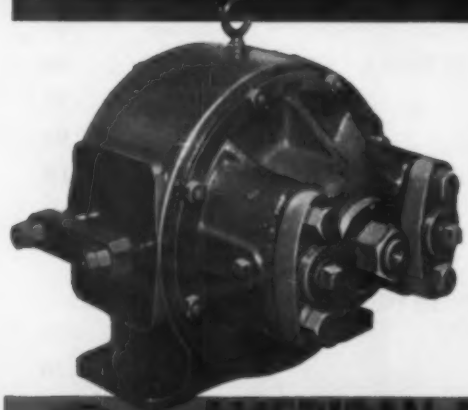
HELE-SHAW and HYDRAMITE

HYDRAULIC PUMPS

for constant displacement . . .
HYDRAMITE

- Pressures to 5,000 psi
- Capacities of 3, 5, 10 gpm and up
- No supercharging needed
- Efficiencies over 85%
- Either rotation for direct drive

for variable displacement . . .
HELE-SHAW



- Instantly reversible
- From 0 to 3,000 psi
- Capacities from 3 to 110 gpm
- Infinitely variable discharge
- Many types of controls

AMERICAN ENGINEERING COMPANY

Dept. P-141, Wheatsheaf Lane & Sepulva St., Philadelphia 37, Pa.

CANADIAN SUBSIDIARIES: Affiliated Engineering Corporations, Ltd.

Applied Hydraulics

THE MAGAZINE OF FLUID POWER

Published monthly by
THE INDUSTRIAL PUBLISHING CORP.
812 Huron Road, Cleveland 15, Ohio

IRVING B. HEXTER ..... President
LESTER P. AURBACH ..... Executive Vice-President
EDWIN M. JOSEPH ..... Vice-President
LEE HAAS ..... Vice-President

STAFF

PAUL ROLNICK ..... Editor and Publishing Director
ALLAN E. MORRIS ..... Executive Editor
KEITH A. CARLSON ..... Associate Editor
BERT BENKENDORF ..... Associate Editor
SCHOLER BANGS ..... Western Editor, Los Angeles Office
JOHN A. LANKESTER, A.R.Ae.S. ..... European Editor
SUSANN SLIVA ..... Editorial Assistant
ALARIC MAUSSER ..... Art Director
N. G. KISER ..... Circulation Director
ALAN KICHLER ..... General Mgr. Franchised-Dealer Dept.
R. V. STARKS ..... Mgr. Reader Service Dept.

SALES OFFICES

CLEVELAND 15 ..... SUperior 1-9622
R. D. SHATTUCK

NEW YORK 17 ..... MUrray Hill 7-3420
LEE HAAS, Vice-President
V. R. STEIN, Administrative Assistant
RONALD ROSE, Eastern Representative
60 E. 42nd St.—Room 836

CHICAGO 11 ..... WHitehall 3-1655-56-57
CHARLES F. GEYER, Manager
S. R. TRACY
520 N. Michigan Ave.—Room 704

LOS ANGELES 57 ..... DUnkirk 7-5104
ALAN T. CAZIER, Manager
WILLIAM MILLS
Room 8, Granada Building
672 South Lafayette Park Place

LONDON S.W.1 ..... Victoria 2608
JOHN A. LANKESTER, A.R.Ae.S. ..... Manager
31 Palace St., Westminster

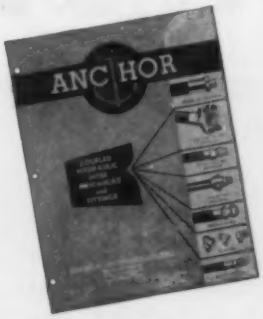
SUBSCRIPTION in United States and possessions—$5.00 per year; Canada—$6.00 per year; Foreign—$7.00 per year, except United Kingdom. United Kingdom subscription £ 2.0.0 per year, payable in Sterling to our London Office. Single copy price, this issue, $.50. All subscriptions subject to individual acceptance by the publisher.

AFFILIATED PUBLICATIONS: COMMERCIAL REFRIGERATION & AIR CONDITIONING, PRECISION METAL MOLDING, FLOW, INDUSTRY & WELDING, OCCUPATIONAL HAZARDS, MODERN OFFICE PROCEDURES, AERONAUTICAL PROCUREMENT, MATERIAL HANDLING ILLUSTRATED, and WELDING ILLUSTRATED. Member, Business Publications Audit of Circulation, Inc.

Accepted as controlled circulation publication at Pontiac, Illinois. Please return 3579 forms to 812 Huron Road, Cleveland 15, Ohio.

Useful Literature

Condensed Catalog Covers Anchor Line



Users and manufacturers of hydraulic equipment will find the Anchor Condensed Catalog No. 57-S a most valuable adjunct to their engineering or maintenance files.

It contains a condensed, yet very complete presentation of the Anchor Line of Hydraulic Hose Assemblies, Couplings and Fittings. The Anchor Line is so reviewed as to greatly simplify selection of the correct Hose Assembly, Coupling or Fitting for any given application.

Included in this catalog are descriptions of the most standard Anchor Products, including Anchor Ductile Sleeve Couplings and other permanently applied Couplings with 2-Wire Braid Hose for high pressures, and with 1-Wire Braid Hi-Burst 2-Rayon Braid, or Spiral Wire Braid for medium and low pressures.

Also described are Anchor Reusable Couplings which include the commercial Duloc Couplings for QW and QWR Hose and Anchor Standard Reusable Couplings with 2-Wire Braid Hose for high pressures, with 1-Wire Braid Hose, Hi-Burst and Standard 2-Rayon Braid Hose for medium and low pressures.

Anchor FLANCO 4-Bolt Split-Flange "O"-Ring Couplings and Clamp-Type Hose Couplings for quick, easy emergency repair are listed.

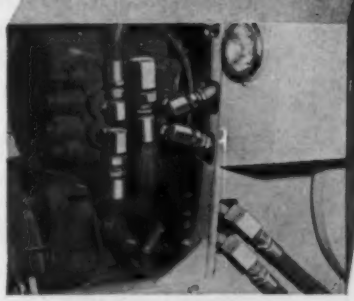
The right fitting to suit practically any piping situation can be found in the Anchor Line of Adapter Unions and Pipe Fittings with its wide range of sizes and thread combinations.

Also shown are the new Anchor SAE Adapters and Fittings designed to SAE Straight Thread "O"-Ring Boss standards, which are carried in stock.

This condensed catalog of Anchor standard stock products is now available on written request. Write Anchor Coupling Co. Inc., 331 North Fourth Street, Libertyville, Illinois, and ask for Catalog No. 57-S.

They're Tough—

and always found where the going is roughest!



We invite you to send us your specifications for recommendations.

ANCHOR®

HYDRAULIC HOSE ASSEMBLIES AND FITTINGS

You mention the hydraulic application and we will recommend, out of our wide variety of styles and complete range of sizes, an Anchor assembly, or fitting, that exactly meets your requirements—and that will deliver a bonus margin of service life. This maze of assorted types of Anchor Hose Assemblies; shown on a Hough Model "HO", 4-Wheel Drive, Payloader Tractor Shovel—reflects the usage of Anchor Assemblies on all famous Hough Tractors. And again, this wide acceptance is repeated on practically all well-known heavy-duty hydraulic driven equipment used where continuous service under severest conditions is mandatory. Anchor Hydraulic Hose Assemblies, Couplings and Related Fittings have long been the preference of leaders, because they are designed to the need and produced under strictest supervision.

ANCHOR COUPLING CO. INC.

331 No. Fourth Street — Libertyville, Ill.

Branch Offices—Dallas, Texas—Plymouth, Michigan

CIRCLE 12 ON READER SERVICE CARD

FLUID POWER LINES

about applied hydraulics

FLUID POWER SOURCES . . . Visitors at the Design Show in Chicago this month, and at the ASTE Show next month in Philadelphia will be impressed by the increasing use of fluid power for industrial machines. Designers are constantly finding new applications for the straight-line and rotary forces they can get with cylinders and fluid motors.

To give a brief background on the sources of fluid power—both hydraulic and pneumatic—the editors of APPLIED HYDRAULICS prepared a basic report in this issue on power sources and have added articles emphasizing application of power sources. Starting on page 77 you'll find articles describing the operation and features of pumps, compressors, accumulators, and boosters. These are the prime movers in fluid power systems; they force air or oil into the actuators which produce work.

Prefacing these basic articles is a summary of 2000 questionnaires sent out by APPLIED HYDRAULICS to learn the preferences and requirements of engineers who use pumps, compressors, and accumulators. The comments were varied and interesting, and came from as widely different fields as missiles and matches.

GETTING TOGETHER . . . Perhaps some day we'll have a motor-pump having a single shaft for both units. Right now, the closest to this ideal, close coupling are the models described on page 94. An internal coupling or special motor end plates eliminate the problem of shaft misalignment.

DECISIONS, DECISIONS . . . If you've got an application requiring high flow at low pressure followed by low flow at high pressure, you've probably considered the various ways of getting it. In his article, *Comparing Pump Power Requirements,* Sanford Ellis shows how he figures power consumption of a fixed displacement pump, hi-lo system, and pressure compensated pump in a typical press cycle.

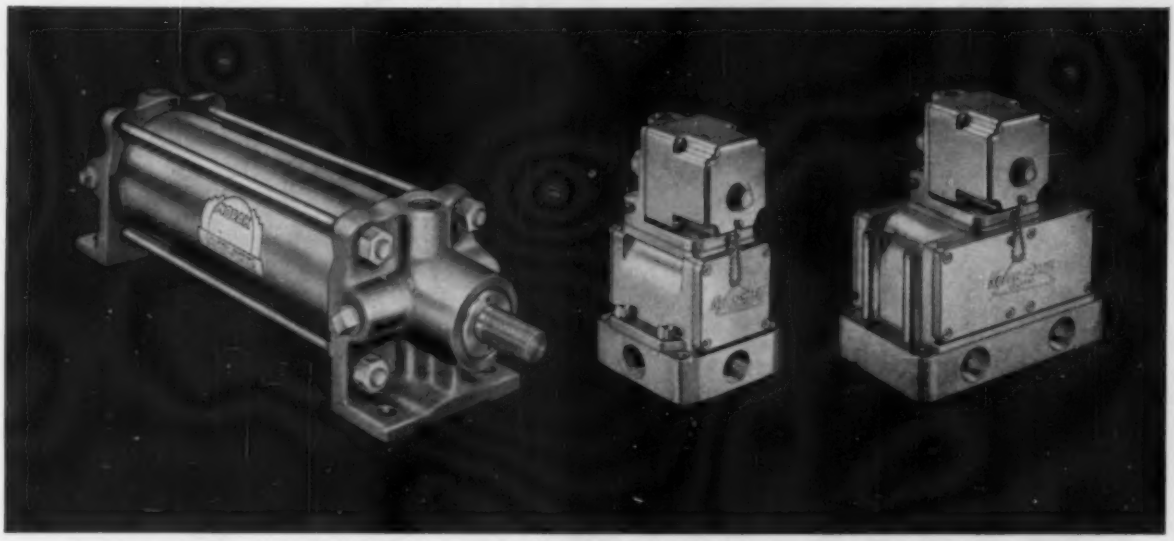
TAKE A GIANT STEP . . . Designers of mobile equipment for construction and material handling will find the story on page 104 interesting reading. It tells how Clark designed its lift trucks for 2000 psi to get faster lifting speeds and better visibility with smaller components.

FROM DOWN UNDER . . . Pleading for more usable pump ratings, Aussie R. W. Johns states his case in the article on page 122. With his gallon consisting of 278 cu. in. and speeds of 1000 and 1500 rpm on 50-cycle current, he's troubled with conversions to U.S. units.

EVERYBODY WINS . . . You can share in the $1200 of top prizes in the APPLIED HYDRAULICS Prize Paper Contest. Even if you should miss the big money, your entry will be published and paid for if judges give it an honorable mention award. Write for a rules booklet and entry blank. Contest closes July 1st.

WHERE TO GO . . . To see the latest developments in fluid power components at the Design Show, use the guide to exhibitors included in this issue. Manufacturers of pumps, valves, cylinders, and other equipment are indicated. For a quick run-down on what you'll see turn to *Along the Aisles* on page 32.

It's NOPAK for fluid power products



When you specify . . . specify Nopak Valves and Cylinders and you are assured of efficient, low-cost performance that will confirm your good judgment through many years of trouble-free service—even under severe working conditions. The wide selection of Nopak air and hydraulic products meets your fluid power requirements.

A Great Team! Nopak Air Cylinders are being used to great advantage with the new Nopak-matic, Pilot Operated, Air Control Valves. Together they have proved a great team in many successful "in plant" and O.E.M. applications. Send for Nopak Catalogs 101 and 105 for complete engineering and application data.

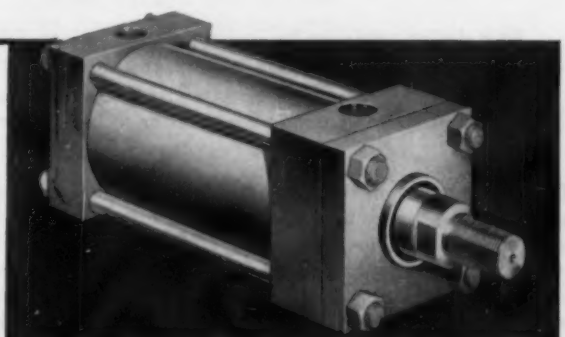
NOPAK Class 1 and 2 Air Cylinders are available in 7 standard mountings in bore sizes from 1½" to 14" with a choice of non-cushioned, self-regulating or adjustable cushioned heads on all models. Class 1 Cylinders, in most standard sizes, are available from Shelf-stock at the factory and other convenient locations. Write for Shelf-stock listings.

Nopak-matic Valves — Nopak-matic, Pilot-operated Poppet-type Air Control Valves are available in ¼", ⅜", ½" and ¾" pipe sizes for 2- or 3-Way normally open or normally closed operation, and 4-Way operation. Master (air), single or double solenoid control heads interchangeable on all models. All valves available, as standard, with choice of side or bottom ported sub-plates. Air pressures to 150 p.s.i.

New NOPAK Square Head Design

Hydraulic Cylinders give you quality, delivery, price, and complete interchangeability with most units of this type. This new line of Nopak Hydraulic Cylinders offers a complete selection of standard mounting styles (15) plus many combinations; a complete range of bore sizes (1½" thru 8"); operating pressures to 2000 p.s.i. and 3000 p.s.i. non-shock; proven design and construction.

Investigate the advantages — you'll specify NOPAK Square Head Hydraulic Cylinders! Send for Catalog 103.



See us at the Tool Show, Philadelphia, May 1-8, Booth No. 834

NOPAK VALVES and CYLINDERS

GALLAND-HENNING NOPAK DIVISION • 2743 South 31st St. • Milwaukee 46, Wis.

"B&W Welded Tubing with special smooth ID finish keeps my fabrication problems to a minimum!

As a design engineer for hydraulic applications, I find that B&W Welded Carbon Steel Mechanical Tubing with special smooth ID finish offers outstanding benefits. The finished condition in which it comes to our plant reduces costs by eliminating a number of fabricating operations."

The uniform finish of this type of tubing means that for many hydraulic applications it can be used "as received" from the mill—eliminating such operations as grinding and polishing. Continuous quality control through every manufacturing operation—with ultrasonic testing supplementing accepted methods of inspection—makes sure that you get tubes matched to your end-use application.

Ask Mr. Tubes, the B&W specialist—he can help you with any tube problem—or write for bulletin TB-428. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

TUBULAR PRODUCTS DIVISION

TA-9009-M2

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals.

Webster

NEW HIGH CAPACITY FLOW DIVIDER

Illustration approx. ½ actual size.

It could have been designed to your exact specifications

Webster's high capacity (60 gpm) flow divider is that versatile. Here's standard design that gives you a free hand in planning your hydraulic circuits — and adapts so easily and economically to your product and the job. With its small size (approx. 6½" x 5⅝" x 2½"), it fits easily in remote locations, tight quarters.

The new flow divider — operating up to 2000 psi — completely eliminates the need for a second pump. It supplies two hydraulic circuits, such as power lift and power steering, and permits each to be operated *simultaneously* at different pressures from *one single pump!* It also has a built-in relief valve on the constant flow section.

Could you use this new Webster flow divider on your product? Benefits like these add up to big dollars, better performance. Write for additional information.

call the man from Webster

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE · WIS

See us at Booth 586 Design Engineering Show

- ☐ Have THE MAN FROM WEBSTER contact us.
- Please send the following:
- ☐ Complete Hydraulic Catalog (H3A3) of pumps, valves, and fluid motors.
- ☐ New information or data as published.

Name .....

Title .....

Company .....

City ..... State .....

CIRCLE 147 ON READER SERVICE CARD

VALVAIR'S universal pilot operates any SPEED KING valve!

Find us fast in the 'Yellow Pages'

Compare ... and you'll buy

Valvair

Immediate delivery from local stock

Valvair's one *universal* pilot—completely interchangeable on all Speed King valves—has only two moving parts. It's built to handle your toughest jobs.

Why complicate production, maintenance and parts inventory on the machines you build or operate, by using control valves that require an assortment of pilots?

For peak performance . . . unmatched reliability . . . minimum parts inventory . . . specify Valvair Speed Kings, the valves with *universal* pilots! Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio.

AA-7215

Representatives in principal cities

. . . Fluid Power news

NEW BULLETIN No. 10600 "ANY-SPEED" DRIVES

WHAT OILGEAR FLUID POWER "ANY-SPEED" ROTARY DRIVES CAN DO FOR YOU!

NEW
32 Pages

Reveals what Oilgear Fluid Power "Any-Speed" Drives are doing, can do, and could do for you on diversified rotary applications. Included are typical performance curves, graphs, applications, and comparisons with other rotary drive methods.

For your copy — without obligation — contact the Oilgear application-engineer in your vicinity. Or write, requesting Oilgear Bulletin No. 10600, directly to . . .

Steering Gear on the U. S. N. S. Eltanin (Hull No. 801) is Oilgear Fluid-Powered

THE OILGEAR COMPANY
Application-Engineered Fluid Power Systems
1564 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Eastman

HIGH PRESSURE ASSEMBLIES

for

Responsive POWER

INSTANT response means extra POWER. Improving the "Power-Performance Ratio" of your equipment may mean an extra bucket per minute, extra tons per hour, extra loads per day.

With the increasing emphasis on POWER, it pays to safeguard the most important link in your hydraulic system with Eastman *High Pressure* Hose and Tube Assemblies.

Eastman Coupling Design gives you maximum orifice, consistent with essential safety and strength, to provide "trigger-response" through unrestricted flow from pump to point of work—plus prompt return.

BENT TUBING TO YOUR SPECIFICATIONS

Eastman's modern, hydraulically-controlled tube bending equipment provides bent tubing to your precise specifications—made with flared or beaded ends for your required fittings. Quality workmanship assures satisfactory performance. Mass production economies assure competitive quotations.

For positive power delivery and efficiency throughout your hydraulic system—plus appearance and sales appeal—it pays to specify Eastman High Pressure Hose and Tube Assemblies for your original equipment.

PERMANENTLY ATTACHED MALE (NPTF)
America's most popular OEM Coupling for 1, 2, and 3 wire braid rubber cover hose, and 4 spiral wire extra high pressure hose.
Sizes: ⅜" thru 3".
Working Pressure: 375-5000 p.s.i.
PERMANENTLY ATTACHED SWIVEL FEMALE
Eastman permanently attached couplings give you a bond stronger than the hose itself! For 1, 2 and 3 wire braid rubber cover hose.
Sizes: ⅜" thru 2".
Working Pressure: 375-5000 p.s.i.
PERMANENTLY ATTACHED FLANGE HEAD COUPLINGS
A no-thread, no-leak "O" ring connection, with split flange and insert available in angles from 0°-90°, for 1 and 2 wire braid rubber cover hose.
Sizes: ¼" thru 2".
Working Pressure: 375-5000 p.s.i.
INTER-LOCK® CLAMP COUPLINGS
Exclusive Combination: Clamp-type coupling with "Inter-Lock" feature and blowout-proof split flange for 1 and 2 wire braid rubber cover hose.
Sizes: ¼" thru 2".
Working Pressure: 375-5000 p.s.i.
2-PIECE REUSABLE SWIVEL FEMALE
Increase serviceability of your original equipment with Eastman Reusable Couplings—for rubber and cotton cover hose.
Sizes: ⅜" thru 1¼".
Working Pressure: 375-5000 p.s.i.

WRITE FOR HIGH PRESSURE CATALOG!

Get on our mailing list to receive out latest Technical Bulletins, Catalogs and Special Inserts.

Eastman
first in the field

MANUFACTURING COMPANY
Dept. AH-4 • MANITOWOC, WISCONSIN

LETTERS to the editor

Address your letters to: Editor, APPLIED HYDRAULIC MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Water Hydraulics

TO THE EDITOR:

I read the article in your February issue concerning water hydraulic systems.

It is very interesting and there is one thing in particular about which I would like to inquire. In the last paragraph you mention pressure reducing valves which operate up to 6000 psi, and I would judge by the application they are relatively large valves.

We have a problem of this nature and I would appreciate very much if you could give me additional information concerning these valves, or perhaps direct me to the company or people who might be able to supply the information.

D. G. LEONARD
Chief Mechanical Engr.
Dow Chemical Co.
Madison Div.
Madison, Ill.

The name of the company manufacturing these valves has been sent you. Reprints of the 16-page *report* Components for Water Hydraulics *are available at* 50c *each.*

Text Books

TO THE EDITOR:

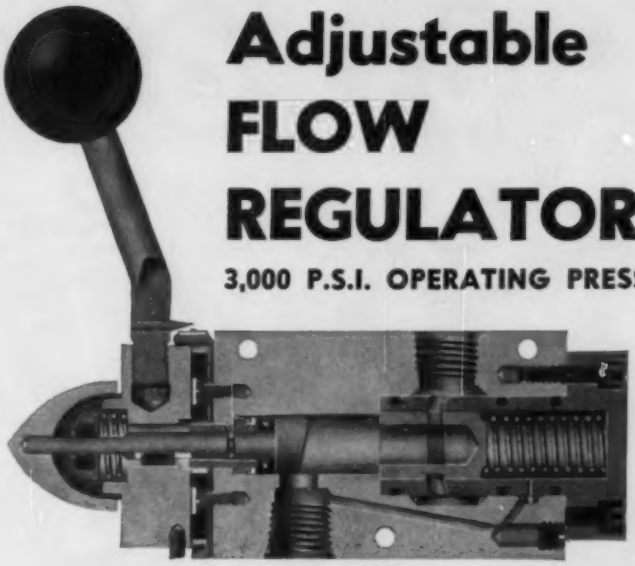
Would you kindly recommend a good text book on the principles of hydraulics, which would be elementary enough to be easily understood and technical enough to give circuits and answers to questions encountered in the field.

ROBERT F. CHASE
Engineering Sales Corp.
Newton Lower Falls, Mass.

We are attaching a page from the recent 1958-59 Fluid Power Directory. *This gives you a list of available books on fluid power.*

We believe that your best basic

Continued on page 16



Adjustable FLOW REGULATOR

3,000 P.S.I. OPERATING PRESSURE

MODEL 1407 Series

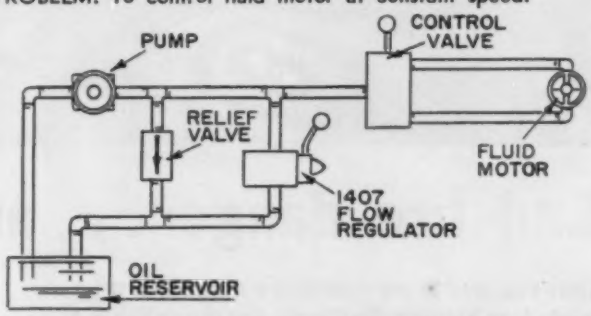
New applications and economical methods of controlling fluid motors and cylinders has prompted our company to design a full range adjustable flow regulator.

Ordering Data

MODEL NO.	MINIMUM FLOW IN G. P. M.	MAXIMUM FLOW IN G. P. M.
1407 R-4-12	0.5	12
1407 L-4-12	0.5	12
1407 R-4-20	0.5	20
1407 L-4-20	0.5	20

R Right Hand—Clockwise rotation from closed to open facing control handle.
L Left Hand —Counter clockwise rotation from closed to open facing control handle.

PROBLEM: To control fluid motor at constant speed.



Model 1407 regulator is a pressure compensated full range adjustable regulator that will maintain constant flow regardless of pressure or load changes. Circuit above allows operation at a pressure equal to load pressure on motor. Speed of motor is controlled by regulating by-pass to reservoir.

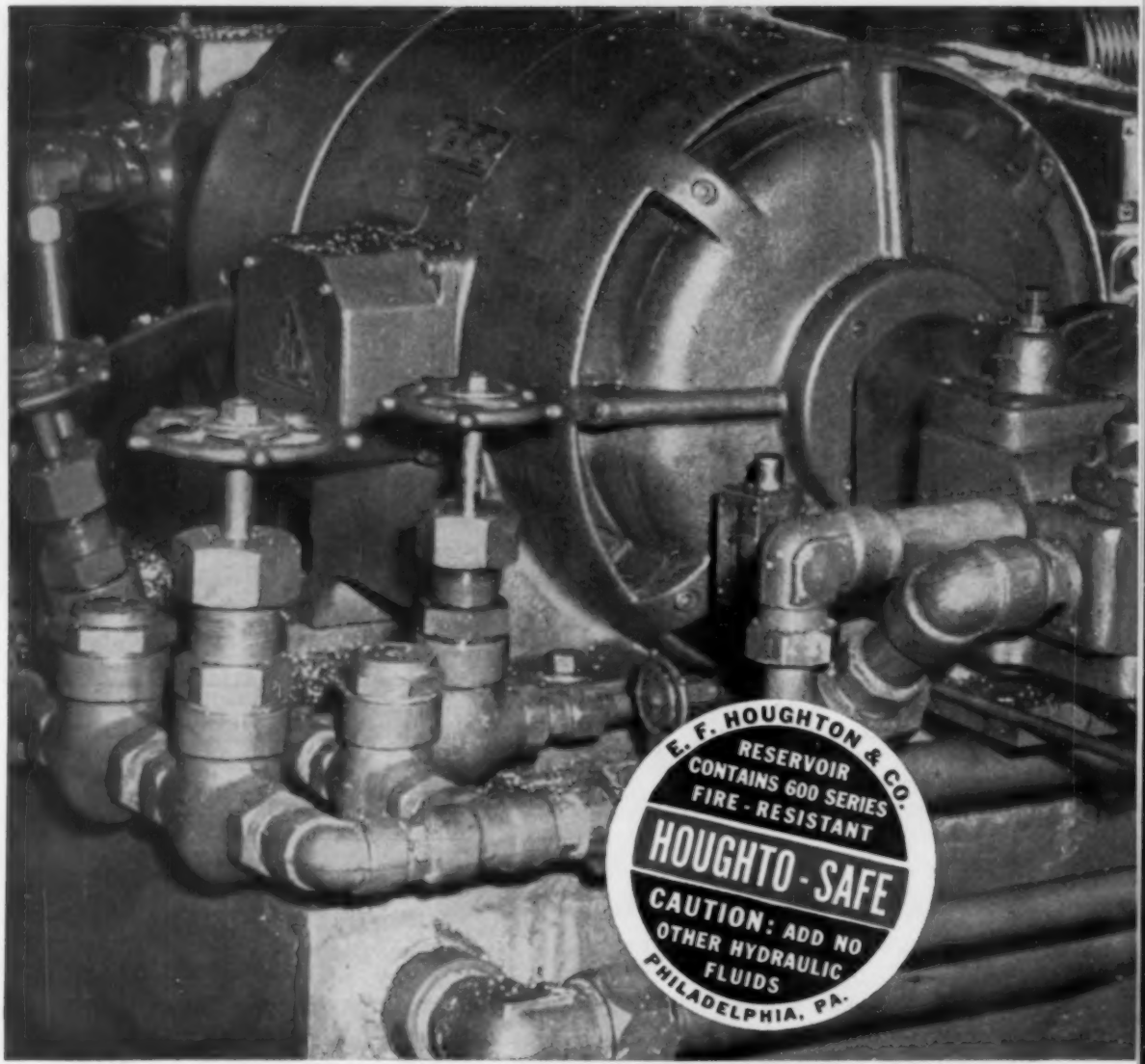
WRITE FOR SHEET 1.04

Other Waterman products:

- **Solenoid Valves**
- **Check Valves**
- **Unloading Valves and Filters**

WATERMAN ENGINEERING COMPANY

725 CUSTER AVENUE EVANSTON, ILLINOIS



End fire danger . . . and hidden hydraulic

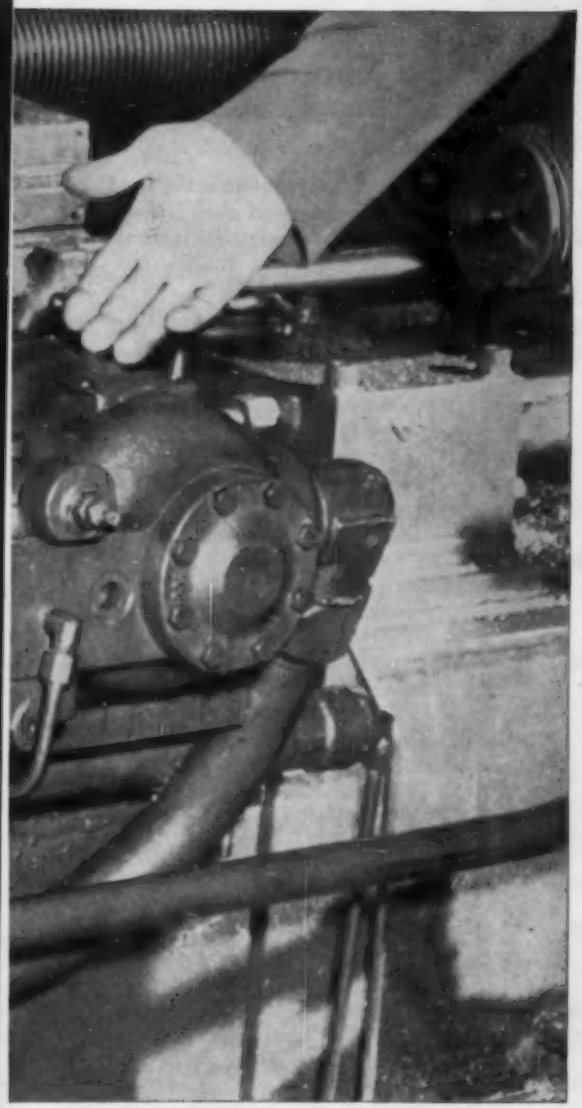
There's no need to pay more than a minimum cost for safety from hydraulic fire danger. And there's no need for costly complications in making a changover to fire-resistant fluids. It's a simple matter of considering lubricating needs, packing compatibility, and overall efficiency . . . then choosing a fluid that answers your requirements. And this is just exactly what Houghton can do for you, because Houghton is the only maker and supplier of all the three separate types of fire-resistant hydraulic fluids needed in covering today's broad range of hydraulic requirements.

You can find out the *real* minimum cost of safety from hydraulic fires *only* by considering *all* factors . . . not only the fluid but its effect on pumps, packings, paint, hoses . . . every part of the hydraulic system it touches. That's just exactly what Houghton does before recommending a fire-resistant fluid for *any* system.

Complete and Unbiased Service

You get this *complete* and unbiased kind of service from Houghton because Houghton supplies all three types of hydraulic fluids used for safety purposes in industry today. The same Houghton engineers and scientists who developed and tested these fluids are ready to apply their know-how to any hydraulic problem you may have. Their knowledge includes not only fluids, but packings, paint, and even pipe compounds desirable for industrial hydraulic equipment.

Their satisfied customers include industry's foremost firms. The U. S. Navy has used Houghto-Safe 600 series fluids for more than four years in the hydraulic catapults that fire fully loaded aircraft



costs, too

from carrier decks. Another Houghto-Safe, the 1000 Series, conforms to the Navy's standard for hydraulic deck-edge elevators.

It's The Same Story With Oils

You can get the benefits of this same Houghton technical service, too, where fire-resistant fluids are not needed. Houghton Hydro-Drive oils cover the full range of hydraulic oil applications. And Houghton also furnishes a superior rust-preventing and lubricating oil additive for systems that use water . . . Hydrolubric.

Check the descriptions of Houghto-Safe fluids at the right. Look over the list of Hydro-Drive fluids, too, if you now use oil-base fluids. Get the latest product bulletin on fluids answering your needs by writing to E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Houghton Hydraulic Fluids for all industrial applications

HOUGHTO-SAFE FIRE-RESISTANT FLUIDS

PHOSPHATE-ESTER FLUIDS—HOUGHTO-SAFE 1000 SERIES

These fluids are available in three viscosities to meet the needs of systems consistently running at temperatures of 150°F. and above, and where maximum lubricity is needed.

WATER-GLYCOL FLUIDS—HOUGHTO-SAFE 600 SERIES

These fluids will adequately meet the requirements of up to 85% of all hydraulic systems. Houghto-Safe 600 Series provides maximum fire protection with good lubricity for systems operating in the lower temperature range.

WATER-OIL EMULSION FLUIDS—HYDROLUBRIC F. R.

These are lower cost fire-resistant fluids. They are stable, afford good lubricity and provide adequate fire protection where hazards are intermittent or remote.

WHERE NO FIRE HAZARD EXISTS... HYDRO-DRIVE

These fortified, high quality oils provide high film strength, maximum protection of moving parts, oxidation stability, gum solvency and protection against rust.

FOR WATER-OPERATED HYDRAULIC SYSTEMS... HYDROLUBRIC

An additive that comes close to turning water into oil. Used 1 to 1000, it lubricates valves, packings. Won't gum up or form scum. Non-corrosive. Won't pit steel, stain copper or brass.

A HOUGHTON Packing for Every Hydraulic Need

HOMOGENEOUS RUBBER

"O" rings, "V", and U-cup packings, diaphragms and molded rubber parts.

FABRICATED RUBBER

Of asbestos cloth or duck, frictioned with synthetic rubber. Available in "V", "U", cup, flange and diaphragms.

VIM LEATHER

Also in "V", "U", cup and flange shapes, plus synthetic rubber-impregnated type, which combines advantages of leather and rubber.

HOUGHTO-SAFE

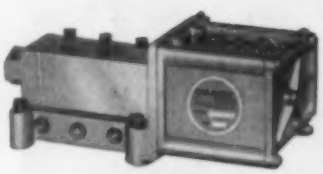
. . . a product of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

CIRCLE 67 ON READER SERVICE CARD

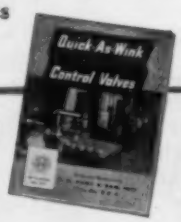
Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves



¼" "O"-Type Single Solenoid 4-way Valve.

½" "B"-Type Lever Operated 4-way Valve.

Play safe. Install Quick-As-Wink valves on **all** your air and hydraulic controls. Positive and fast acting, all operating parts are in pressure balance, avoiding any tendency to creep or crawl. You'll get month after month and year after year of long, dependable, trouble-free — **and safe** — service. There's nothing better than a Quick-As-Wink Control Valve. Can you afford to gamble with less? Sizes from ¼" to 4". Hand, foot, cam, pilot, diaphragm or solenoid operated. Thousands of different types, sizes and actions. Get full details.



Write for **BULLETIN NO. 571** *Today.*

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Mfd. by **C. B. HUNT & SON, INC., 1994 East Pershing St., Salem, Ohio**
Engineering and Sales Representatives in the Principal Cities

LETTERS

source for information is the Fluid Power Directory. *A sheet is available giving you complete information.*

TO THE EDITOR:

I have read your book *Air and Oil Cylinders in Industrial Applications,* by Elmer F. Heiser. This is a very good book for explaining the construction and operation of cylinders. It was written and illustrated so that anyone reading it would have an understanding of the subject.

We were wondering if you have a book written in a similar manner covering electricity and electrical circuits. Our territorial sales managers often encounter electrical circuitry problems and need some basic information on the subject.

If such a book is available, we will send a copy to each of them, as we did with your book on cylinders.

BERNARD G. MICHELS
Manager Drilling Equipment
The Dumore Co.
Racine, Wis.

Sorry we don't have a similar book on electricity and electrical circuits. Perhaps you could check with the Superintendent of Documents, Washington 25, D. C. The Government has put out some good training manuals. They may have one on electricity which would serve your purpose.

January Issue

TO THE EDITOR:

We are very much interested in obtaining eight additional copies of your January 1958 issue of APPLIED HYDRAULICS magazine. We are primarily interested in the section, *Quick Guide to Product Selection.*

In this issue you stated that the guide covered only manufacturers of 34 products. We would be interested to know if you have available a guide of this type with an

Continued on page 18

Fastest in-the-field replacement!

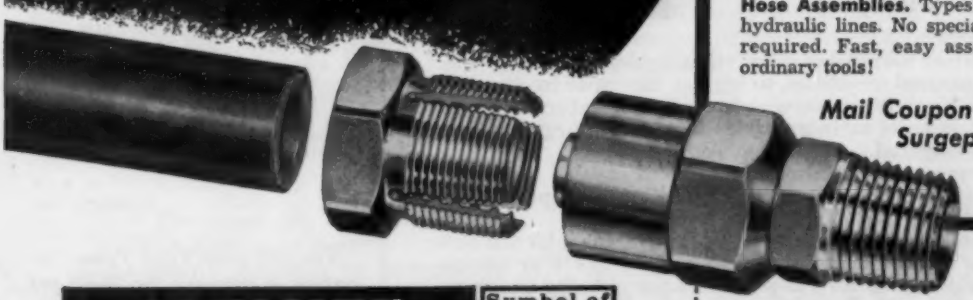
First choice for original equipment!

The Complete Line of

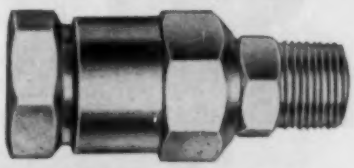
ALEMITE SURGEPRUF

REUSABLE COUPLINGS AND HYDRAULIC HOSE

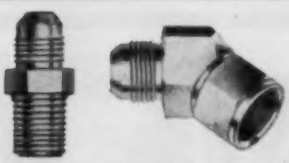
...with a full line of components nationally available!



Single- and Double-Wire Hose For Medium-High Pressure and High-Pressure Service. Seamless inner tube of synthetic rubber, reinforced steel wire braid, and synthetic rubber outer cover. Resists abrasion, weather, and oil. Hose temperature operating range: —40° F. to +275° F.



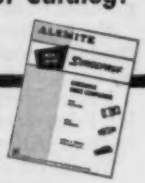
Couplings. Made of high-strength steel. "Double-wedge grip" forces coupling threads through rubber cover . . . grips either single- or double-wire braid firmly. Saves both time and labor!



Adapters and Swivel Adapters. Full range of sizes in J.I.C. and other threads. One-piece adapters—and swivel union adapters to simplify assembly and avoid twisting strain in cramped quarters.

Hose Assemblies. Types and sizes for all hydraulic lines. No special assembly tools required. Fast, easy assembly with just ordinary tools!

Mail Coupon for Surgepruf Catalog!



ALEMITE DIVISION **STEWART-WARNER** CORPORATION

Symbol of **SW** Excellence

1850 Diversey Parkway, Chicago 14, Illinois

ALEMITE, Dept. EE-48
1850 Diversey Parkway, Chicago 14, Illinois

Please send me your catalogs of Surgepruf couplings, hose and components.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

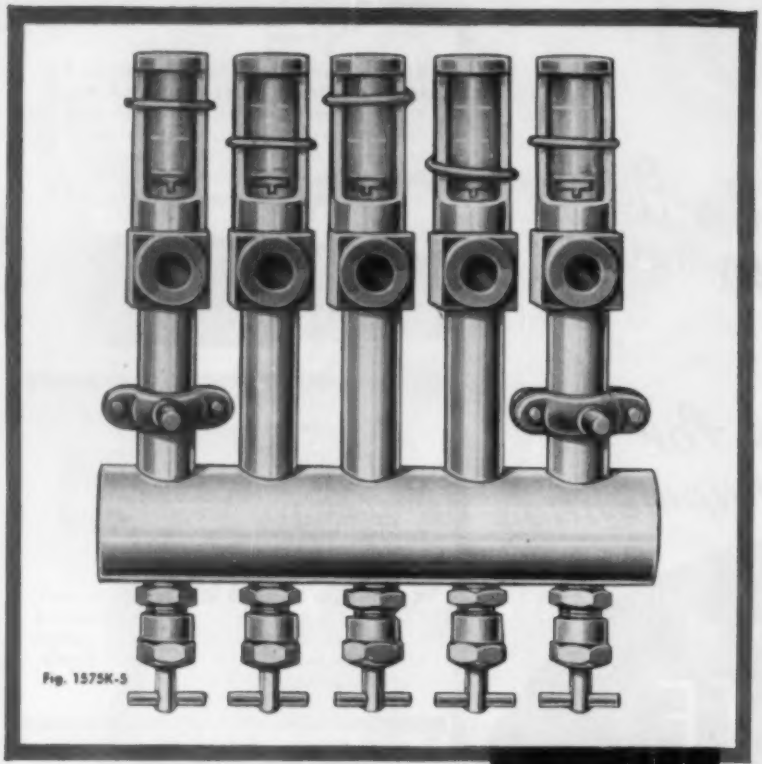


Fig. 1575K-5

NEW

. . from NUGENT

PRESSURE SIGHT FLOW LUBRICATORS

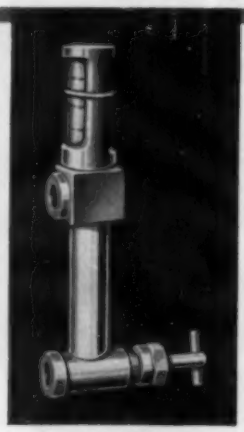


Fig. 1575

Now you can deliver lubricating oil or other liquids under pressure, in accurately measured quantities, to high or otherwise inaccessible points with the Nugent pressure sight flow lubricator. They are available as single units or in multiples to 15 depending upon the number of feeds required.

Each lubricator making up a multiple unit is capable of feeding fluid in amounts varying from several drops to two pints per minute by simple adjustment of the individual needle valves.

Single lubricators are available with 1/4" or 3/8" ips inlet and outlet. Inlet sizes of multiple units range to 3/4" ips with 1/4" or 3/8" ips outlets. All are designed for 125 psi maximum working pressure.

Write for complete details.

ESTABLISHED 1897

WM. W. NUGENT & CO., INC.

3432 CLEVELAND STREET, SKOKIE, ILLINOIS

REPRESENTATIVES IN PRINCIPAL CITIES

OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

LETTERS

extended range of products and manufacturers.

RAYMOND L. WOODS
Magnolia Petroleum Co.
Dallas, Texas

Complete copies of our Designers' Guide Issue *are available at* $1.00 *per copy.*

We also publish the hard bound Fluid Power Directory. *It contains a complete manufacturers' directory to* 140 *products,* 350 *pages of manufacturers' catalogs, a trade name section, and a* 224*-page technical section. Price per copy is* $6.50.

TO THE EDITOR:

May we compliment you on the January *Designers' Guide Issue,* realizing the tremendous task of gathering and cataloging the useful information included.

However, it is necessary to point out an omission with respect to the products of our company under the heading of Packings.

C. W. Marsh Co. should be listed as producing packings of impregnated leather. The listing should also include packings for mobile-use, fire-resistant fluids, and flanges over 10-in. I.D.

C. C. BRADBURY
President
C. W. Marsh Co.
Muskegon, Mich.

Literature Available

TO THE EDITOR:

Please send me a list of available literature on hydraulic and pneumatic circuits.

G. WADE
Hamilton, Ont.

The 796 *page Fluid Power Directory is available for* $6.50 *per copy.* A Beginners Course in Basic Pneumatics *is available as a complete* 64*-page booklet at* $1.50 *per copy. We have sent you a bulletin sheet which gives you information about the books* Air and Hydraulic Cylinders, The Fluid Power Directory, *and* Aircraft Hydraulic Design. ▼▼▼

CHOICE OF BUILT-IN VALVES GIVES CONTROL FLEXIBILITY

SINGLE AIR CONNECTION SIMPLIFIES INSTALLATION

RUGGED CONSTRUCTION ASSURES LONG LIFE

125 BELLOWS SALES AND SERVICE FIELD ENGINEERS

■ There are one or more Bellows Field Engineers in every industrial area of the United States and Canada. They will be happy to work with you in applying "Controlled-Air-Power" to your machine designs. They are listed in their local phone directories under "The Bellows Co."

758-8

Four reasons why THE BELLOWS AIR MOTOR stands first with design engineers

In designing for air cylinder operation the engineer wants first of all sure, positive control, easily interlocked to related machine movements.
He has it in The Bellows Air Motor.

He wants simple installation, uncomplicated by cumbersome piping.
He has it in The Bellows Air Motor.

He wants rugged construction — an air cylinder that will stand up day in and day out with minimum requirements for service and repairs.
He has it in The Bellows Air Motor.

But he also wants the knowledge, if service should ever be needed, that it is quickly available wherever his machine may go.
He has it in The Bellows Air Motor.

The Bellows Co.

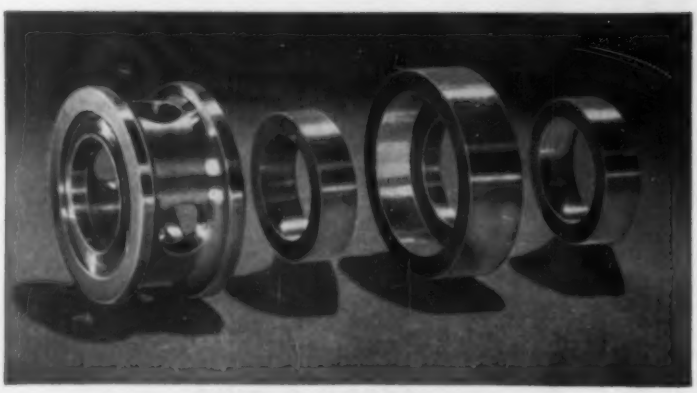
AKRON 9, OHIO

This free booklet offers interesting data for the design engineer. Write for it today. Address Dept. AH-458. Ask for Bulletin BM-25. The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd.

SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media ... with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a ⅝" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 1504 Hamburg Street, Baltimore 3, Maryland.

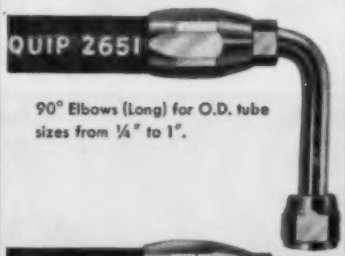
KOPPERS

MECHANICAL SHAFT SEALS

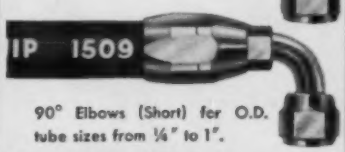
Engineered Products sold with *Service*

Simplify Fluid Line Installation in Confined Spaces with Aeroquip Elbow Hose Fittings and Assemblies

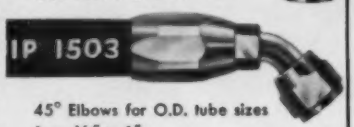
ELBOW FITTINGS AVAILABLE
Swivel Nut Ends—S.A.E & J.I.C.



90° Elbows (Long) for O.D. tube sizes from ¼" to 1".

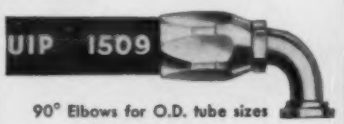


90° Elbows (Short) for O.D. tube sizes from ¼" to 1".



45° Elbows for O.D. tube sizes from ¼" to 1"

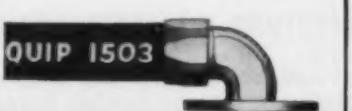
Split Flange Ends—"O" Ring Shoulder



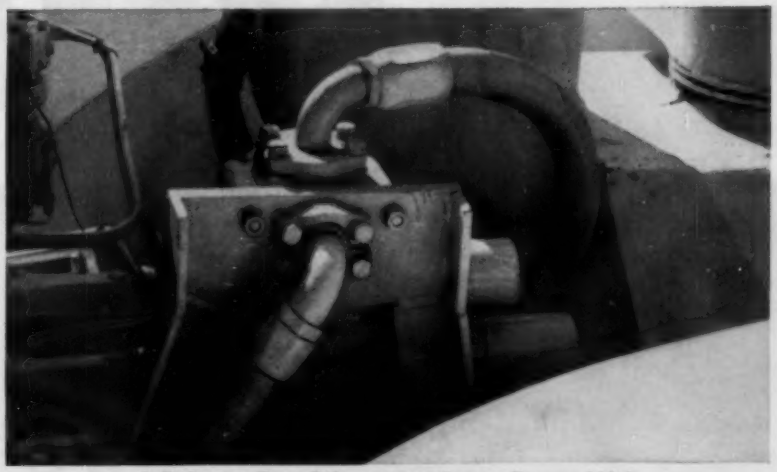
90° Elbows for O.D. tube sizes from ½" to 2".

45° Elbows for O.D. tube sizes from ½" to 2".

Standard 4-Hole Flange Ends

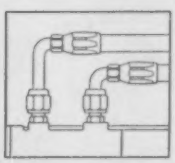


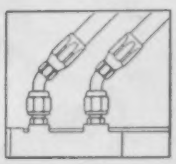
90° Elbows for 2½" & 3" O.D. pipe.



Split flange elbow fittings connecting medium and high pressure hydraulic lines on construction equipment.

Where fluid line routing is complex and space is limited, hose assemblies with elbow fittings can be especially helpful to good design and simple installation. Elbow fittings provide fewer parts, adapters and joints, shorten assembly time,





and permit compact hose bends and contours without placing stress on the hose itself.

Aeroquip offers elbow fittings and hose for a wide range of industrial applications, in end connections to fit S.A.E. and J.I.C. swivel nut, standard flange and split flange systems. And, every Aeroquip Elbow Fitting is completely detachable from the hose. This permits reuse of the fitting again and again when making replacement hose lines, with substantial savings in maintenance time and money.

Full information on Aeroquip Reusable Elbow Fittings and Hose is available to product designers. Fill in and mail the coupon below for the engineering bulletins you want plus a handy guide for routing and installation of Aeroquip Hose Assemblies. Complete engineering assistance is available to manufacturers.

Aeroquip Corporation
Jackson, Michigan

Please send me a copy of "Guide for Routing and Installation of Aeroquip Flexible Hose Assemblies" plus the following engineering bulletins: AH-4

☐ IEB-3 on Split Flange Elbow Fittings

☐ IEB-27 on Swivel Nut Elbow Fittings

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

See Aeroquip Products on Display at the Design Engineering Show April 14 thru 17, Chicago International Amphitheatre Booth 305

Aeroquip
REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Introducing the revolutionary new MAC 4-way

DUAL-

Feature spool-within-a-spool design . . . operate with unmatched efficiency . . . sell for about half the price of most other ½" to 1¼" valves . . . meet all J.I.C. specifications

Designed around a revolutionary spool-within-a-spool, here are air valves the industry has long needed and wanted.

They are tops for performance—operating at speeds equal to any known usage—with shorter stroke, direct operation and a highly efficient *circular* air flow.

Also they operate on the *low current requirements of minimum amplified circuits*—needing just .8 amperes of inrush current.

The valves are compact, too. They are about one-half the size of similar-use competitive valves (½" to 1¼") . . . sell at about half the price in single-solenoid models. You save even more in the double-solenoid models.

There are other savings. Fewer parts and simple design reduce maintenance. Integral conduit boxes connected by wiring duct permit optional wiring. Plug-in lead connectors speed up installation. The MACsolenoid—which operates up to *30 million cycles* without appreciable wear—shaves replacement costs to a minimum.

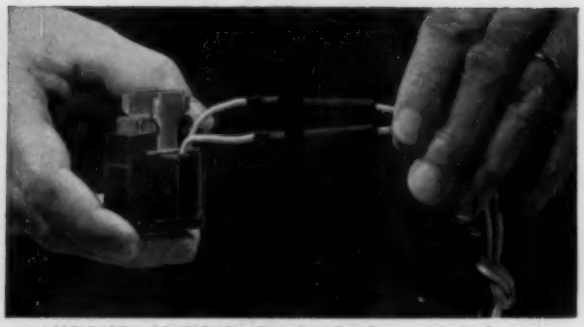
Check the other advantages at the right. Then contact a MAC representative or write direct for all details. The 4-Way Dual-Spool air valves are now available in ½", ¾", 1" and 1¼" pipe sizes. They are quality built throughout . . . meet or exceed *all* J.I.C. standards . . . are fully tested and guaranteed.

Pat. applied for on all valve features ©MAC

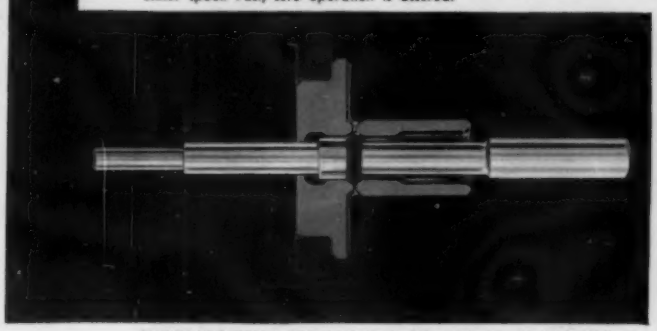
SPOOL

CIRCULAR-FLOW AIR VALVE

SPLIT-SECOND OPERATION—In MAC's exclusive Dual-Spool design, the inner spool operates through the core of the larger outer spool. The MACsolenoid energizes the inner spool, releasing compressed air to activate the outer spool. There is no lag between movement of either spool. Fast, sure operation is assured.



MACSOLENOID CONTROLLED—The Dual-Spool's proved MAC-solenoid has new waterproof plug-in wire lead connectors that are not rigid-mounted . . . thus are vibration-proof. The solenoid and cover assembly detach in seconds without tools. Valve is electrically inoperative with the cover off. Tests at better than 600 cycles per minute.



SHOCK PROTECTED—The shock load of the main spool is dissipated through "shear"-loaded floating heads located at spool ends. The rubber cushions soften the impact, lengthen valve life.

CIRCULAR AIR FLOW—In above double-image photograph, air space is illustrated: air circulates more freely, unhampered by right-angle turns. Valve provides full air flow throughout rated capacities.

MECHANICAL AIR CONTROLS, INC. MAC 10030 Capital, Oak Park, Detroit 37, Michigan

GET THE FACTS FROM YOUR NEAREST "MAC" REPRESENTATIVE.

ARKANSAS
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102

CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221

SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521

FLORIDA
MIAMI SPRINGS—Aero Hardware & Supply Inc., 4301 Northwest 36th St., TUxedo 8-2414

ILLINOIS AND IOWA
CHICAGO 6—Walter Norris Engineering Co., Civic Opera Bldg., 20 N. Wacker Dr., STate 2-2804

INDIANA
EVANSVILLE 14—Neff Engineering Co., 2509 Washington Ave., GReenleaf 7-4181

FORT WAYNE 3—Neff Engineering Co., Station A, P.O. Box 2001, 2339 Crescent Ave., EAstbrook 7391

INDIANAPOLIS 2—Neff Engineering Co., 1955 Central Ave., WAlnut 5-5311

SOUTH BEND—Neff Engineering Co., 707 South Eddy St., ATlantic 7-5655

MARYLAND (and Dist. of Columbia)
BALTIMORE 18—N. B. Cochrane Co., 100 E. 20th St., HOpkins 7-4884

MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 So. Chilson St., TWinbrook 2-2629

FLINT 2—Kober Sales Engineering Co., 1115 Bank St., CEdar 2-7165

WESTERN MICHIGAN—Everett Adkins, 17212 Sharon Road, Chesaning, Michigan, Victor 5-3446

MINNESOTA
MINNEAPOLIS 8—Air & Hydraulic Equipment Co., 15 E. 38th St., TAylor 3-6118

MISSISSIPPI
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102

MISSOURI
ST. LOUIS COUNTY—Oscar E. Just Co., P.O. Box 6, St. Ann, HArrison 8-4488

NEW JERSEY
(NORTHERN) Machinery & Machine Supplies Co., Inc., 305 East 47th St., New York 17, New York, PLaza 8-0744
(SOUTHERN) Automation Aides, 1618 Willow Ave., Philadelphia 26, LaMott, Pennsylvania, MElrose 5-5565

NEW YORK
BUFFALO 26—C. H. Tapas Co., 137 Lamarck Drive, Circle 3210
NEW YORK 17—Machinery & Machine Supplies Co., Inc., 305 East 47th Street, PLaza 8-0744

OHIO
CINCINNATI 2—Fluid Power Engineering Co., 205 Keith Bldg., MAin 1-6640
CLEVELAND 9 (PARMA)—Fluid Power Engineering Co., 5451 Broadview Rd., Florida 1-1190

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., CApitol 3-2295

PENNSYLVANIA
PHILADELPHIA 26, LaMOTT—Automation Aides, 1618 Willow Ave., MElrose 5-5565
PITTSBURGH—Machinery & Machine Supplies Co., Inc., 1307 Rutherford St., LEhigh 1-1235

TENNESSEE
MEMPHIS 5—Branch-Merwin Tool Specialists, 477 N. Bellevue, BRoadway 8-6102

TEXAS
DALLAS 35—Womack Machine Supply Co., 2010 Shea Road, FLeetwood 7-3671

WASHINGTON
SEATTLE—The Rucker Co., 1900 4th Ave., South, MAin 2763

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 No. Pt. Washington Rd., EDgewood 2-1579

CANADA
MONTREAL—L. S. Tarshis & Sons, Ltd., 450 McGill St., Quebec, PLateau 2963
TORONTO—Trevor Babbs, National Time & Signal Co., 72 Shilton Rd., Agincourt, Ontario, OXford 1-4857

ACCO
Helicoid Gage
U.S.A.

NOTHING BUT THE BEST IN GAGES FOR WORKING PRESSURES FROM 30" VACUUM TO 10,000 p. s. i.

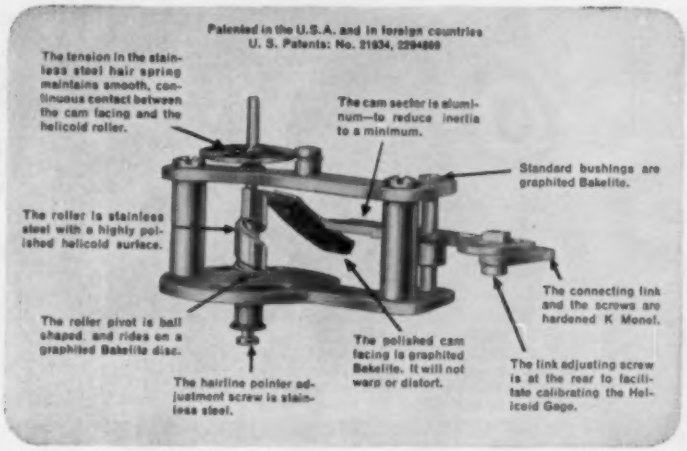
Shock-Proof Cam Actuation (no gears—no teeth) Makes Helicoid Gages Ideal for Hydraulic Services

Designed for pulsating and impact hydraulic service, the Helicoid movement releases at zero in the event of sudden pressure reduction. This eliminates shock on pointer and movement by reducing impact of pointer against pointer stop pin. This protects the gage mechanism where gages may be subject to occasional vacuum.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or certain severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown at the right.

Rolling action of the cam facing against the roller surface . . . graphited Bakelite bushings, roller pivot base and cam facing . . . K Monel connecting links and screws . . . all such Helicoid features protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation through millions of cycles.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21634, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

HELICOID GAGE CARTRIDGE SNUBBER

(Patent pending)

This is a simple, effective throttling device to reduce or eliminate pulsations of the gage pointer. There are no moving parts, no adjustments needed. Available in three types in powdered bronze or stainless steel for air, gas, water, steam, medium or heavy liquids.

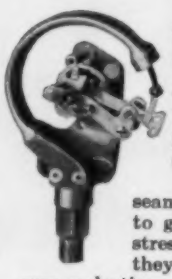
Enlarged cutaway view

Threaded cartridge body for assembly in any Helicoid Gage tapped socket shank

EASIEST ADJUSTMENT AND CALIBRATION

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

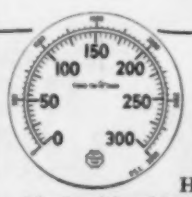
Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.



TUBES BUILT FOR MILLIONS OF PRESSURE PULSATIONS

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak nor crack.



DOUBLE SCALE DIAL SHOWS TONS ON RAM AND PSI

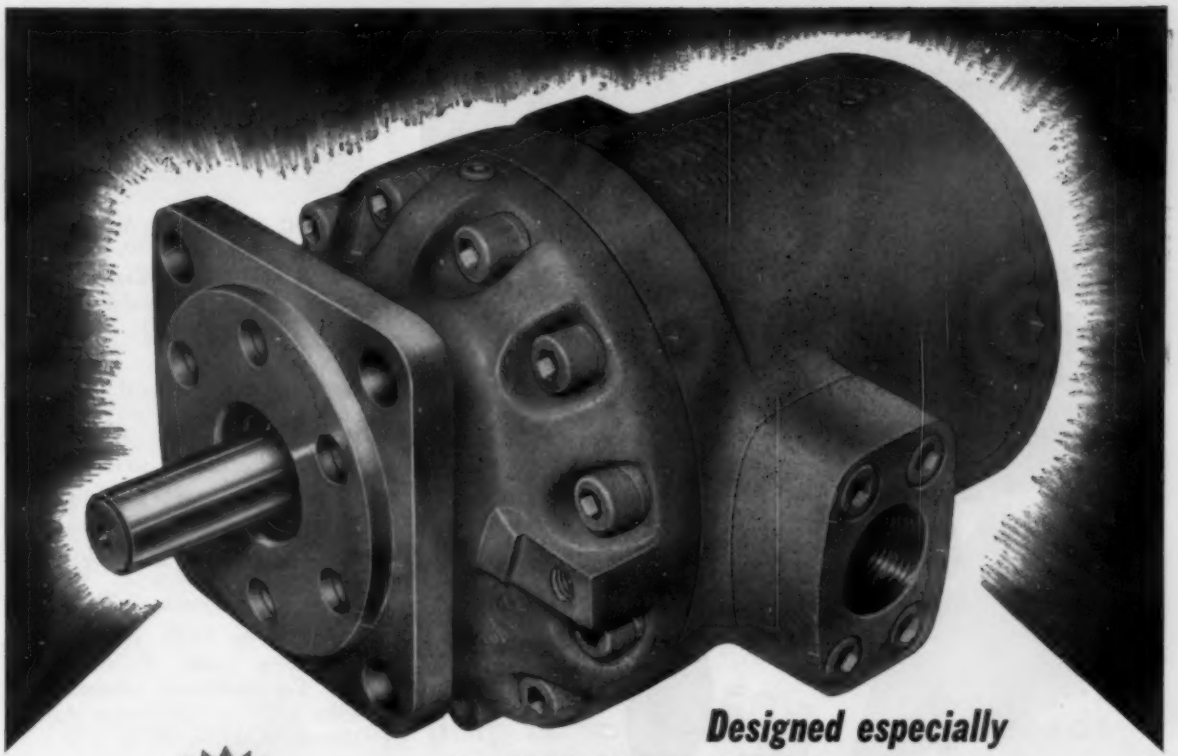
Helicoid Gage dials are supplied in jet black with white figure markings or in dull white with black figure markings. They are constructed of laminated phenol with a transparent plastic surface and the longest possible scale length for more accurate readings. They are non-corroding, will not discolor nor fade and will not crack, chip nor peel.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-H Connecticut Avenue • Bridgeport 2, Connecticut

ACCO
A C C
TRADE MARK

Helicoid gives you all these features at prices that are competitive in the quality gage field



Designed especially for 2000-3000 psi industrial service...

The NEW BERRY HYDRAULIC PUMP/MOTOR

Has these important features:

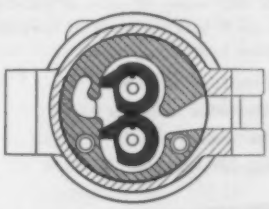
- ★ **Maximum torque at "stall"**
- ★ **Design proven in oil, gas, elevator and lumber industries**
- ★ **Competitively priced**
- ★ **Will carry overhung chain or belt loads**
- ★ **Flange or foot mounted**
- ★ **Instantly reversible**
- ★ **Smooth, constant torque at all speeds**

Write

for complete information and data on suitability for your application.

BERRY HYDRAULICS

A DIVISION OF OLIVER TYRONE CORPORATION
ROOM 2241 OLIVER BUILDING, PITTSBURGH 22, PA.



Schematic diagram above shows one of the two sets of pistons in the sturdy Berry Rotary Piston design.

CHARACTERISTICS
Models A-12 and A-12B

Drive Shaft Rotation	Reversible
Working Pressure	2000 psi
Surge Pressure	3000 psi

Operated as a Pump

Drive Shaft Speed—Maximum	1200 rpm
Displacement	12 gpm*

**Capacities from 7.5 to 12 gpm at rated speed are also available.*

Operated as a Motor

Drive Shaft Speed—Maximum	1800 rpm
Displacement—CIR	2.356
Displacement—GPR	.0102
Theoretical Torque inch lbs./100 psi	37.4

Your Tight Specifications Require the Tightest Seal!

MARSH IMPREGNATED THERMO-LEATHER PACKINGS

...still the BEST by TEST and USE

MARSH has the *right* answer to your specific packing requirements. Extensive research plus nearly 60 years of packing experience is your assurance of complete satisfaction in *every* application.

- Low coefficient of friction
- Greater wear resistance
- Tighter sealing
- Temperature stability

LEATHER—The No. 1 Sealer

Field experience is continuously proving —on job after job—that leather, both standard and impregnated, is still far superior to all other types of material—since it is the only known media which has the fine needed desire in installation of conforming to the house in which it is placed.

Let's solve your packing problems together!

Engineering and Consulting Service

If you seal oil, water, air, vacuum, gas, gasoline, naptha, alcohol or other fluids, ask MARSH for field engineering service, immediately available to you for the job you are designing, tooling, manufacturing.

MARSH BEST SINCE 1900 LEATHER PACKINGS

C. W. MARSH COMPANY

MAIN OFFICE AND FACTORY • MUSKEGON, MICHIGAN

SALES OFFICES: 75 E. Wacker Drive, Chicago 1, Illinois · 101 Park Avenue, New York 17, New York · 1900 Euclid Avenue, Cleveland 15, Ohio

FUTURE EVENTS

April 8-11: SAE Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display. Hotel Commodore, New York, N. Y.

April 14-17: Design Engineering Show, International Amphitheatre, Chicago. Write Clapp & Poliak, 341 Madison Ave., New York 17, for further details.

April 29: Meeting, Fluid Power Systems Div., Philadelphia Section, ASME. Subject, Hydraulic Applications of Cableways and Tramways.

May 1-8: ASTE Tool Show, Convention Center, Philadelphia, Pa. For complete information write ASTE, 10700 Puritan Ave., Detroit 38, Mich.

May 14-15: First European Fluid Power Conference, St. Ermins Hotel, London S. W. 1, England. For complete details write to Compressed Air and Hydraulics, Temple Chambers, Temple Ave., London E. C. 4, England.

June 2-4: National Fluid Power Association Annual Spring Meeting, Bedford Springs Hotel, Bedford, Pa.

June 9-12: American Society of Mechanical Engineers national conference on materials handling. Public Auditorium, Cleveland, Ohio.

June 9-13: Fourth Annual Automation Seminar at The Pennsylvania State University. Theme, "Cost Reduction Through Automation". Contact Chester Linsky, in charge of automation at the University, for further information.

September 29-October 3: ASTE Semi-Annual Meeting and Western Tool Show. Shrine Exposition Hall, Los Angeles, Calif.

October 16-17: NCIH 14th Annual Meeting. Sherman Hotel, Chicago, Ill. For complete information write Raymond D. Meade, Conference Secretary, Illinois Institute of Technology, Chicago, Ill. ▼▼▼

NEW

TUTHILL POWERMAX

Hydraulic pumps and Fluid motors

- **For pressures to 1500 psi**
- **Pump capacities from 1.2 to 14.2 gpm**
- **For speeds to 3600 rpm**

TUTHILL, producers of quality pumps since 1927, proudly announces its new line of POWERMAX hydraulic pumps and fluid motors. Produced in a complete selection of seven different models, these rugged, compact new units incorporate the quality construction and advanced engineering that industry has learned to expect from TUTHILL.

POWERMAX pumps and fluid motors use precision-ground, involute spur gears of heat-treated alloy steel, especially designed for efficient and quiet operation. Large, heavy-duty, anti-friction bearings . . . hard, long-wearing, double wear plates of a special bronze alloy . . . double lip-type shaft seals . . . generously proportioned heat-treated alloy steel shaft . . . these are just a few of the many quality construction features which insure long, trouble-free life for POWERMAX pumps and motors.

The compact design of these units saves space and simplifies installation problems. They can be provided for either flange or foot mounting and with either side or rear ports as standard (front porting is available on special order). POWERMAX pumps or motors may be supplied with a built-in relief valve if desired.

Duplex or tandem models

For applications such as power steering where two pumps of substantially different operating characteristics are required, POWERMAX pumps may be furnished in duplex or tandem models, with both units mounted on a single shaft. This allows substantial savings through the elimination of a second driving source, reductions in hydraulic piping, and lower installation costs.

A new Catalog, No. 111, gives complete information on these new POWERMAX pumps and hydraulic motors. Included are performance curves, dimensional data, construction features . . . all the detailed engineering information you need. Write today for your copy.

TUTHILL PUMP COMPANY
981 East 95th Street, Chicago 19, Illinois

☐ Please forward copy of Catalog No. 111 on new POWERMAX hydraulic pumps and fluid motors.

☐ Please have your representative call.

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From 1 to 200 GMP; for Pressures to 1500 PSI; speeds to 3600 RPM.

TUTHILL PUMP COMPANY

981 East 95th Street, Chicago 19, Illinois

Canadian Affiliate:
Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada

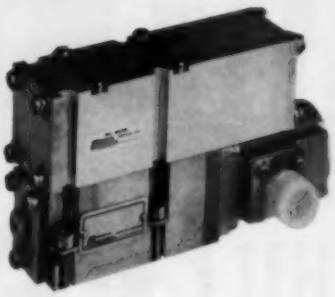
PUMPS FOR YOUR PURPOSE

CIRCLE 137 ON READER SERVICE CARD

Now...from a single source...

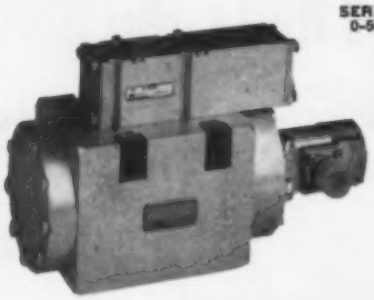
THE FIRST COMPLETE LINE OF ELECTRO-HYDRAULIC SERVO VALVES

SERIES 100
0-5 gpm

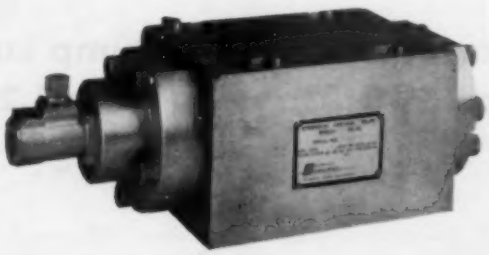


SERIES 200
0-10 gpm

SERIES 300
0-50 gpm



SERIES 500
0-200 gpm



Sanders BOOTSTRAP(T) *Servo Valves for all industrial, marine and aircraft applications*

Sanders Electro-Hydraulic Servo Valves are based on the reliability-proved "BOOTSTRAP" two stage internal force feedback principal. This design converts low input into powerful thrusts, while providing high internal stiffness of control.

These valves have high frequency response, high resolution and low threshold. Large-area internal pilot stage filters plus large orifices and nozzles add up to extra reliability. Manifold mounting allows flexibility in external connections.

Sanders' extensive application experience is at your service in solving servo valve and hydraulic system problems. Extensive manufacturing facilities assure fast, economical production. For complete details about specifications, prices and delivery schedules, write:

TYPICAL SPECIFICATIONS

	SERIES 100	SERIES 200	SERIES 300	SERIES 500
Flow Range (GPM at 1000 psi ΔP)	0-5	0-10	0-50	0-200
Supply Pressure (psi)	200-3000	200-5000	200-3000	500-3000
Overall Size (inches)	2¼ x 2¼ x 2½	5¾ x 1½ x 3	8⅜ x 3¼ x 5⅛	15¼ x 6½ x 4¾
Approximate Weight (pounds)	1.0	3.6	7.5	35.0
Nominal Input Power (watts)	0.1	0.2	1.0	1.0
Coil Resistance (ohms/coil)	100-3000	100-3000	100-3000	100-3000
Amplitude Ratio	–3db at 150 cps	–3db at 80 cps	–3db at 60 cps	–3db at 30 cps
Phase Lag	90° at 150 cps	90° at 80 cps	90° at 60 cps	90° at 30 cps

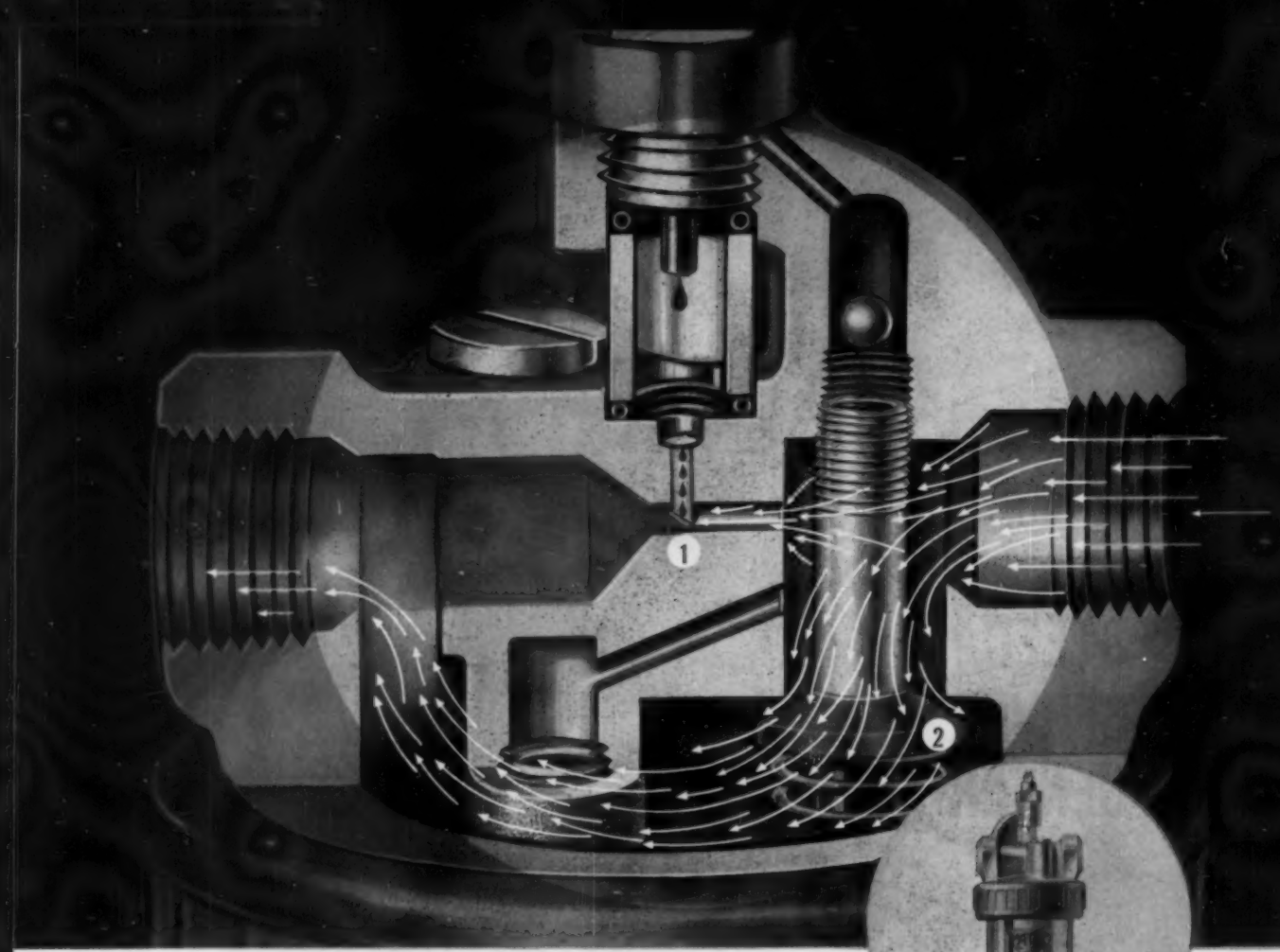
(T) TRADEMARK—SANDERS ASSOCIATES, INC.

SANDERS ASSOCIATES, INC.

DEPT. B, NASHUA 4, NEW HAMPSHIRE • *Inglewood, California* • *Washington, D.C.*

CIRCLE 176 ON READER SERVICE CARD

CIRCLE 145 →



Wide range performance made possible in a single unit because ❶ exclusive small venturi section provides efficient lubrication at air flow rates as low as 1 CFM, ❷ exclusive automatic bypass valve maintains lubrication at high air flow rates with negligible pressure drop.

Now! EFFICIENT pneumatic equipment LUBRICATION AT ALL AIR FLOW RATES

Enough oil — but not too much. A fine mist at *any* flow rate . . . ultra-fine, enduring atomization that assures *efficient* lubrication. Tools, chucks, cylinders, other air equipment function smoothly at *any* speed when lubricated by Watts air line lubricators.

You get optimum efficiency from these advanced-design units because Watts has *specialized* in protection and control devices since 1875. Exclusive features and precision construction assure reliable, lowest-cost performance.

WATTS FILTERS — exclusive "TORNADO ACTION" provides really clean dry air

Filter life is extended by extreme centrifugal force which spirals dirt and moisture particles downward into "quiet zone", leaving only a minute percentage of the finest and lightest particles to be trapped by the filter cone.

WATTS REGULATORS — sensitive "Aspirator Action" maintains more uniform pressure

Aspirator acts directly on diaphragm giving instant compensation for fluctuating load demands . . . provides precise control and stabilizes pressures reaching individual pieces of equipment.

Write for free technical catalog. Charts, diagrams, performance data enable you to specify the right Watts pneumatic equipment right on the spot!

WATTS

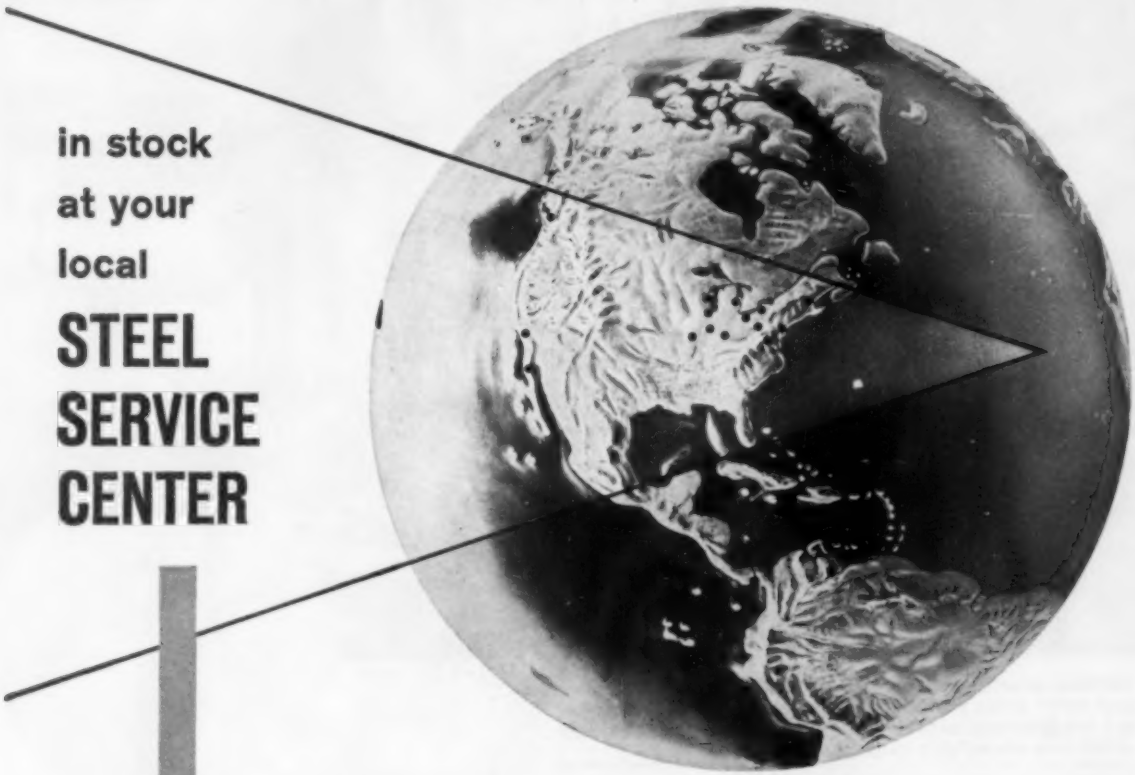
FILTERS
REGULATORS
LUBRICATORS

Visit **WATTS** at the **ASTE** Tool Show Booth 967

Watts Regulator Company — Industrial Division — 6 Embankment Road — Lawrence, Massachusetts

ROCKRITE® TUBING-

in stock
at your
local
STEEL SERVICE CENTER



You can depend on your local steel service centers throughout the country to give you fast, dependable service on ROCKRITE *cylinder-finish* seamless tubing. Whatever your requirements...a single piece or a carload...you will always find a complete range of sizes immediately available from warehouse stock.

ROCKRITE Tubing was developed for use "as supplied" for cylinder applications. To the fine surfaces and close tolerances are added higher mechanical properties and exceptional machining qualities.

Write today for ROCKRITE Bulletin R7A and the name of your nearest steel service center.

Tube Reducing Corporation also is exclusive licensee for the "Niphos" process of nickel-phosphide coating to make mild steels corrosion resistant.

ROCKRITE® TUBING

TUBE REDUCING CORPORATION

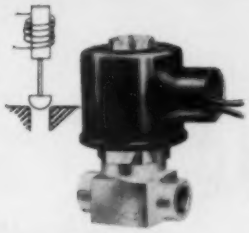
520 MAIN AVENUE, WALLINGTON, NEW JERSEY

Mailing Address: P. O. Box 959-A Passaic, N. J.

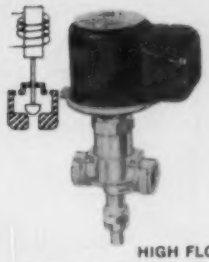
9-111

CIRCLE 136 ON READER SERVICE CARD

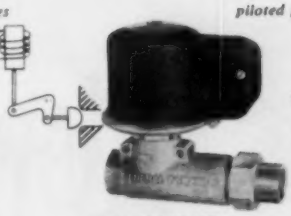
these six basic valves will meet any electric valve requirement you have



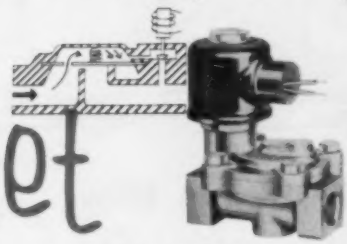
GENERAL PURPOSE
direct acting solenoid valves



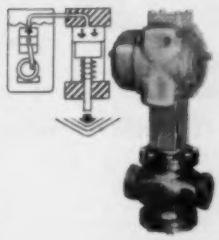
HIGH FLOW
piloted piston solenoid valves



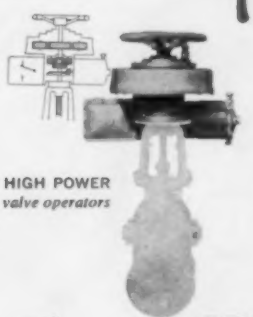
HIGH PRESSURE
lever action solenoid valves



HIGH FLOW
magnetic diaphragm valves



HIGH VOLUME
HIGH PRESSURE
Hydramotor valves



HIGH POWER
Tork-Master valve operators

FROM 1/8" TO 60" PIPE SIZE

- normally open
- normally closed
- three-way
- four-way
- two-wire or three-wire control
- explosion-proof and weatherproof
- special body and seat materials
- odd voltages AC and DC
- UL, FM and AGA approvals

And with these GENERAL CONTROLS valves you get not only a complete range of sizes... but the right combination of operator *and* valve to do the job right... in terms of operating power, speed, capacity, flow characteristics and safety. You'll find the answer to your every electric valve problem in these GENERAL CONTROLS valves. Send for basic electric valve catalogs today.

GENERAL CONTROLS

Manufacturers of America's Finest Automatic Controls for Home, Industry and the Military

Glendale, Calif. • Skokie, Ill. • Guelph, Ontario, Canada

Six Plants—42 factory branch offices serving the United States and Canada

. . . at the Design Show
April 14-17 • Chicago

Booth

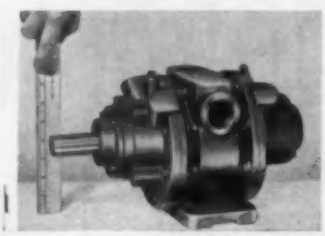
118 Parker-Hannifin Corp.

You'll see . . . a new line of tube fittings with a specially treated flare nose for sealing under severe pressure and temperature conditions. Treatment consists of a thin coating of Teflon to fill up tool marks and other irregularities on the flare.

CIRCLE 201 ON READER SERVICE CARD

1013 Gast Mfg. Corp.

You'll see . . . a 7 hp rotary air motor that is only 7-⅝ in. high and weighs 65 lbs. From 300 rpm and up, speed is



variable by increasing or decreasing the air supplied to the motor. Seven hp rating is at 2000 rpm.

CIRCLE 202 ON READER SERVICE CARD

653 The Polymer Corporation

You'll see . . . Nylaflow pressure tubing carrying compressed air and hydraulic oil on working equipment. With a 4 to 1 safety factory, pressures to 600 psi are handled.

CIRCLE 203 ON READER SERVICE CARD

960 Micro Switch Division of Minneapolis-Honeywell Regulator Co.

You'll see . . . a complete line of precision switches. One of these being displayed for the first time is a plug-in limit switch that can be replaced without removing the wiring connections.

CIRCLE 204 ON READER SERVICE CARD

Continued on page 40

Rivoira and Moncher To Speak At Design Conference

Edward J. Rivoira, manager of the electro-hydraulic and gaging division of Cincinnati Milling Machine Co. will speak on *Electro-Hydraulic Systems on Machine Tools* at the Design Conference in Chicago. The four day conference will be held concurrently with the Design Engineering Show (April 14 to 17) and is sponsored by the ASME. Another talk, *Electro-hydraulic Systems on Aircraft* will be presented by F. L. Moncher, Director of Engineering, Aero-Hydraulic Division, Vickers, Inc. and L. D. Taylor, Assistant Chief Development Engineer, Research and Development Division, Vickers Inc. Both talks will be made on Tuesday, April 15. ▼▼▼

COLLEGE OF CYLINDER KNOWLEDGE

offering the original
"College Course"
plus the new
"Post Graduate Course"
on

SEALS
FLUIDS and
CYLINDERS

...in pleasant minutes at

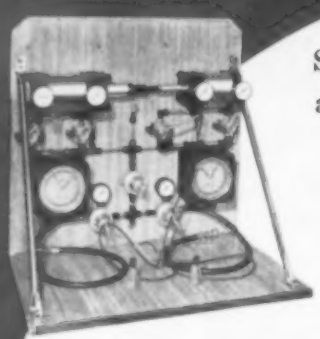
Booth 839
Design Engineering Show—Chicago, April 14-17

Booth 1625
A.S.T.E. Show—Philadelphia, May 1-8

Miller - MILLER FLUID POWER

The "College" gives you...in minutes...the results of

BASIC COLLEGE COURSE

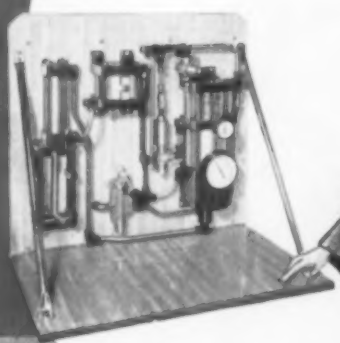


Shows you how to eliminate downtime, maintenance ... and improve performance.

Knowledge-packed lessons—made entertaining and exciting with "live" demonstrations of cylinders, boosters, and accumulators in actual operation.

See

how you can test your cylinders for efficiency and leakage—in a minute or two!

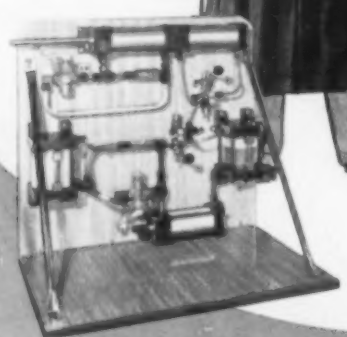


Learn

what makes cylinders safe-operating, long-lived, efficient!

Discover

the many uses and advantages of hydraulic pressure (up to 10,000 psi) obtained directly from your shop air.



Get all this

plus a wealth of other revealing data on power cylinders, boosters, air-oil circuits, accumulators, etc. . . . demonstrated and explained by our College "Professors" in fascinating lessons that require only minutes of your time.

Win this bona-fide diploma for completing the course and receive, also, the complete "College" Text Book containing 32 pages of valuable data.

s of years of research, experience and testing

POST GRADUATE COURSE

Of Special Interest To Our More Than 300,000 Graduates

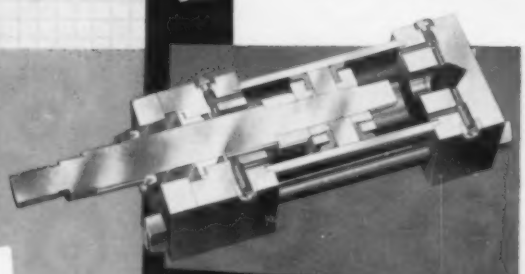
You'll enjoy this opportunity of taking our "College of Cylinder Knowledge" Post Graduate Course covering

SEALS and FLUIDS

Petroleum base, fire-resistant and special hydraulic fluids—together with the high temperatures developed in many hydraulic circuits—are playing havoc with many of the seals used in hydraulic cylinders, causing leakage, costly repairs, and cylinder failure.

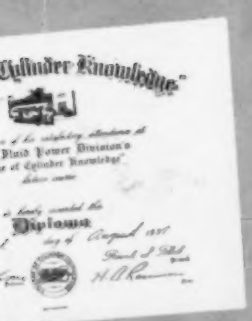
Our Post Graduate Course gives you an academic appraisal of the various hydraulic fluids and sealing materials available, their effect upon each other, and their temperature limitations—so that you can select the fluids and seals that best fit your needs.

See, also, the new developments in fittings for threaded connections, which permit easy sealing and positioning of fittings and lines.



CYLINDERS

Learn how to evaluate various cylinder designs and materials for varying pressures and operating conditions.



"COLLEGE OF CYLINDER KNOWLEDGE"

is presented at Booth 1625
. . . courtesy of the

Miller - MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION
2040 N. Hawthorne Avenue, Melrose Park, Illinois

Manufacturers of Cylinders, Boosters, Accumulators

CIRCLE 94 ON READER SERVICE CARD

HERE'S YOUR GUIDE TO EXHIBITORS OF FLUI

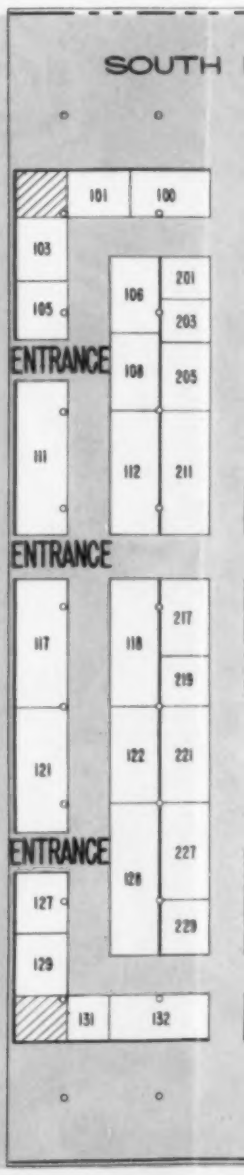
1958 DESIGN

APRIL 14-17 INTERNATIONAL AMI

Booth	Exhibitor
305	Aeroquip Corp.
846	Air-Maze Corp.
311	Alemite Div., Stewart Warner Corp.
101	Almar Hydraulic Valve Co.
541	APPLIED HYDRAULICS Magazine
563	Atkomatic Valve Company, Inc.
481,	483, 485 Automatic Switch Co.
583	Barco Manufacturing Company
883	The Bellows Company
561	Benton Harbor Engineering Works, Inc.
527	Chicago-Allis Manufacturing Corp.
528,	534 Chicago Rawhide Manufacturing Co.
733	Commercial Shearing & Stamping Co.
555	Crane Packing Company
1059	Cross Manufacturing Company
1033	The Cuno Engineering Corp.
634	Dixon Automatic Tool, Inc.
1062	Dura-metallic Corp.
301	Eagle Signal Corporation
937	Elastic Stop Nut Corp. of America
228	Electro Snap Switch & Manufacturing Company
205	Flexonics Corporation
1029	Flodar Corporation
714	The Garlock Packing Company
1013	Gast Manufacturing Corporation
585	General Controls Company
862	The Hillard Corporation
321	Hoke Incorporated
432	Homestead Valve & Manufacturing Co.
950	E. F. Houghton & Company
580	Humphrey Products Div., General Gas Light Co.

Booth	Exhibitor
842	Hupp Aviation Company
471	The Imperial Brass Manufacturing Company
633	International Packings Corp.
438	L & L Manufacturing Company
522,	524 Licon Division of Illinois Tool Works
701,	709, 713, 717 Linde Company, Div. of Union Carbide Corp.
537	Lovejoy Flexible Coupling Co.
956	Marvel Engineering Company
960	Micro Switch Division, Minneapolis-Honeywell Regulator Co.
839,	845, 849 Miller Fluid Power Co., Div. of Flick-Reedy Corp.
482	Oil-Dyne, Incorporated
118	Parker Hannifin Corp.
653	The Polymer Corporation of Pennsylvania
518	Raybestos-Manhattan, Inc.
858	Resistoflex Corporation
425	M. H. Rhodes, Incorporated
423	Roper Hydraulics, Incorporated
825	Ross Operating Valve Company
435	Sanders Associates, Incorporated
749	A. Schrader's Son Div., Scovill Manufacturing Co.
1042	Sealol Corporation
940	Skinner Electric Valve Division
458	Sparta Manufacturing Company
437	Stratoflex, Incorporated
628	Superior Tube Company
938	Titeflex, Incorporated
465	Tuthill Pump Company
212	U. S. Electrical Motors Inc.
567	Valcor Engineering Corporation
762,	768 Vickers Incorporated
558	Wagner Electric Corp.
657,	659 The Weatherhead Company, Fort Wayne Division
586	Webster Electric Company

Floor plan for Design Show ↓



AND A GUIDE TO EXHIBITORS OF FLUID POWER

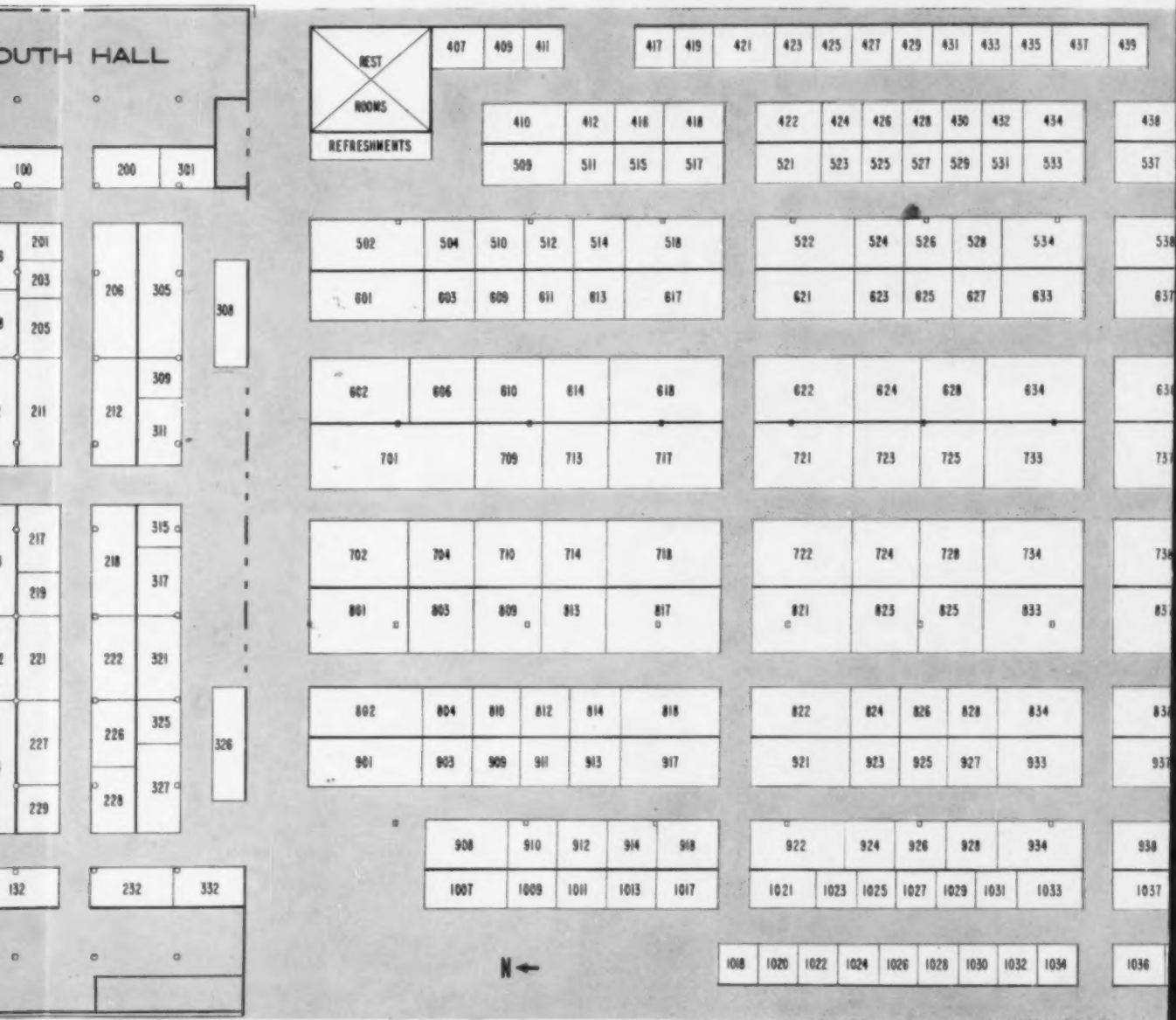
1958 ASTE TOOL

MAY 1-8 · CONVENTION CENTER ·

FLUID POWER PRODUCTS AT THE

GN ENGINEERING SH

AMPHITHEATRE · CHICAGO



VER PRODUCTS AT THE

L SHOW

· PHILADELPHIA

Booth			
1154	Alkon Products Corp.	2042	Hofma
1838	Automatic Switch Co.	1900	Humph
1244	Carter Controls, Inc.		Genera
1012	Denison Engineering Div., American Brake Shoe Co.	529	C. B. H
834	Galland-Henning Manufacturing Co.	1652	Logans
713	Hanna Engineering Works	1459	M-B Pr
		1302	Mead S

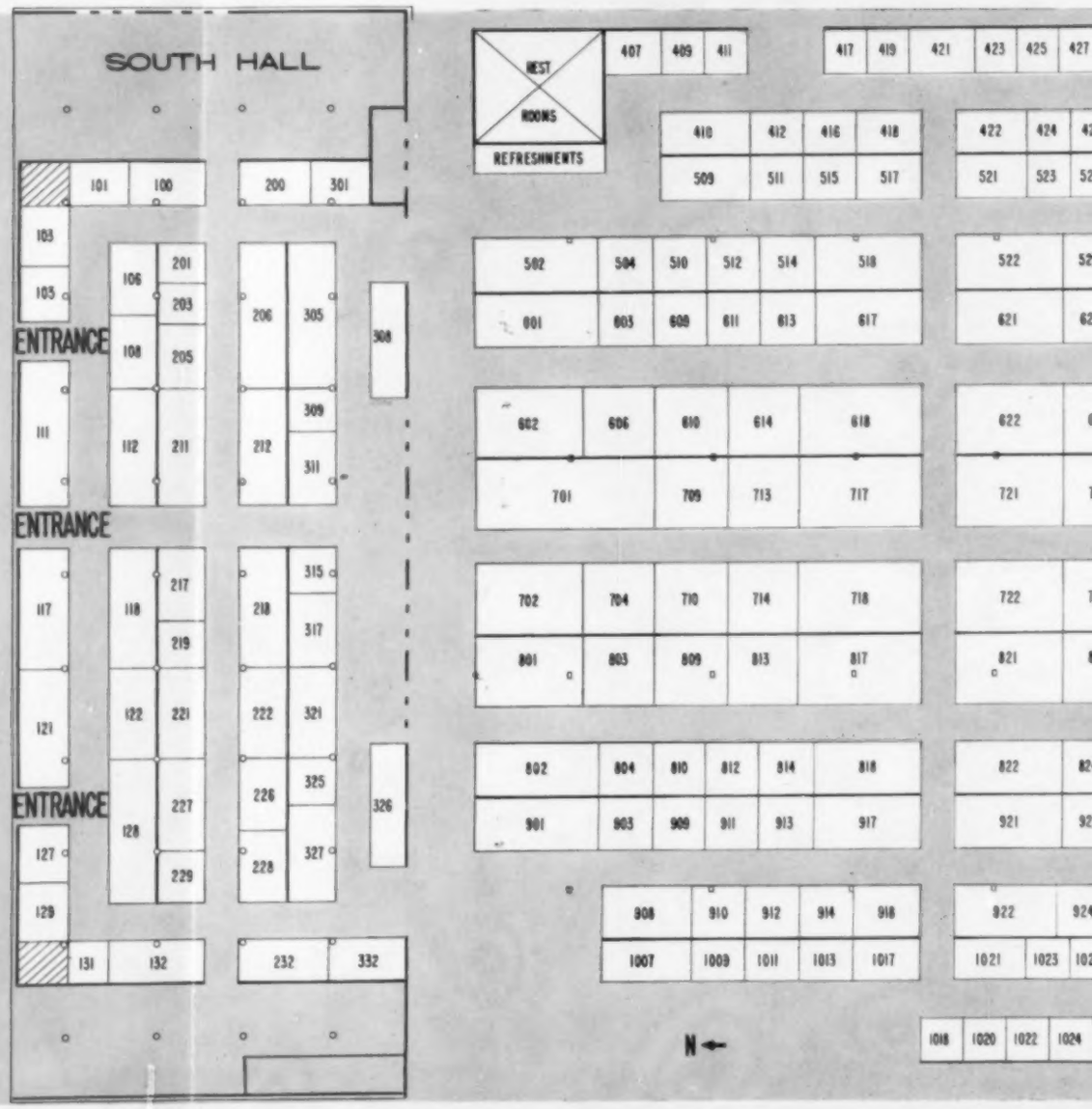
OUR GUIDE TO EXHIBITORS OF FLUID POWER PRODUCTS AT THE

1958 DESIGN ENGINEERING

14-17 INTERNATIONAL AMPHITHEATRE · CHICAGO

Booth	Exhibitor
842	Hupp Aviation Company
471	The Imperial Brass Manufacturing Company
633	International Packings Corp.
438	L & L Manufacturing Company
522, 524	Licon Division of Illinois Tool Works
701, 709, 713, 717	Linde Company, Div. of Union Carbide Corp.
537	Lovejoy Flexible Coupling Co.
956	Marvel Engineering Company
960	Micro Switch Division, Minneapolis-Honeywell Regulator Co.
839, 845, 849	Miller Fluid Power Co., Div. of Flick-Reedy Corp.
482	Oil-Dyne, Incorporated
118	Parker Hannifin Corp.
653	The Polymer Corporation of Pennsylvania
518	Raybestos-Manhattan, Inc.
858	Resistoflex Corporation
425	M. H. Rhodes, Incorporated
423	Roper Hydraulics, Incorporated
825	Ross Operating Valve Company
435	Sanders Associates, Incorporated
749	A. Schrader's Son Div., Scovill Manufacturing Co.
1042	Sealol Corporation
940	Skinner Electric Valve Division
458	Sparta Manufacturing Company
437	Stratoflex, Incorporated
628	Superior Tube Company
938	Titeflex, Incorporated
465	Tuthill Pump Company
212	U. S. Electrical Motors Inc.
567	Valcor Engineering Corporation
762, 768	Vickers Incorporated
558	Wagner Electric Corp.
657, 659	The Weatherhead Company, Fort Wayne Division
586	Webster Electric Company

Floor plan for Design Show ↓



E TO EXHIBITORS OF FLUID POWER PRODUCTS AT THE

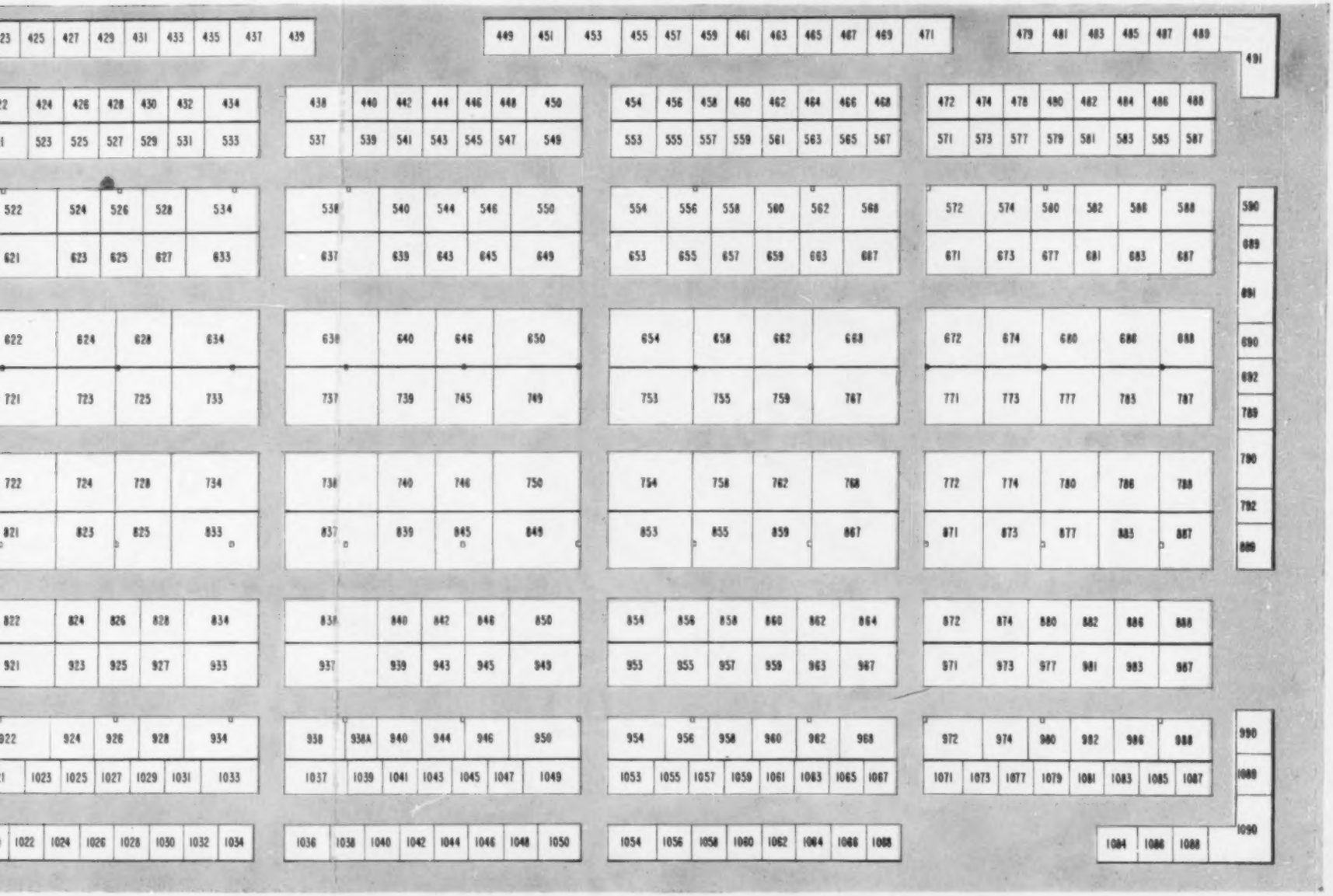
ASTE TOOL SHOW

CONVENTION CENTER · PHILADELPHIA

Booth	
1154	Alkon Products Co
1838	Automatic Switch
1244	Carter Controls, I
1012	Denison Engineerin American Brake Sh
834	Galland-Henning Co.
713	Hanna Engineering

NG SHOW

Applied Hydraulics
THE MAGAZINE OF FLUID POWER



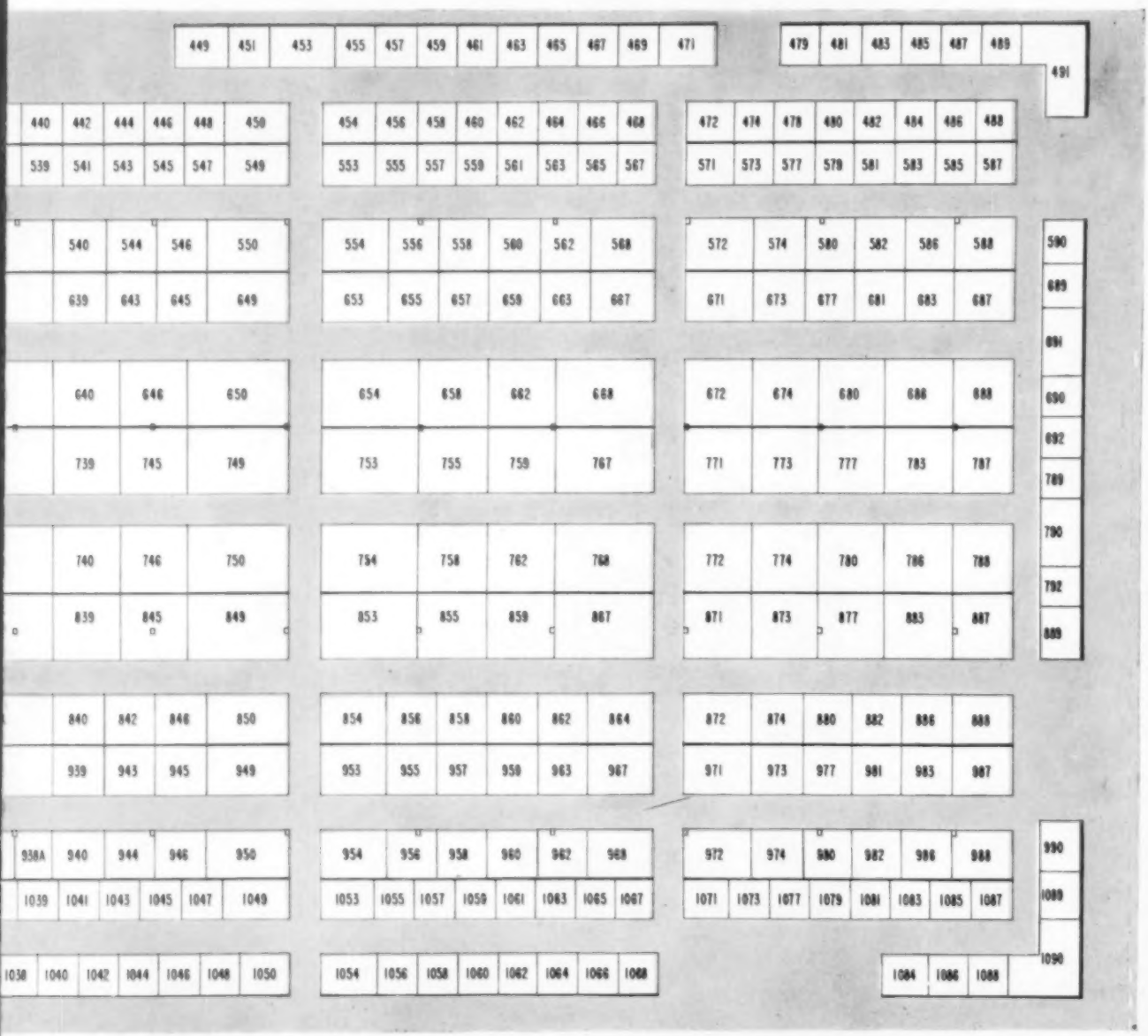
oducts Corp.
tic Switch Co.
Controls, Inc.
Engineering Div.,
n Brake Shoe Co.
-Henning Manufacturing
ngineering Works

2042 Hofmann Engineering Company
1900 Humphrey Products Div.
General Gas Light Corp.
529 C. B. Hunt & Son Inc.
1652 Logansport Machine Co., Inc.
1459 M-B Products Inc.
1302 Mead Specialties Company

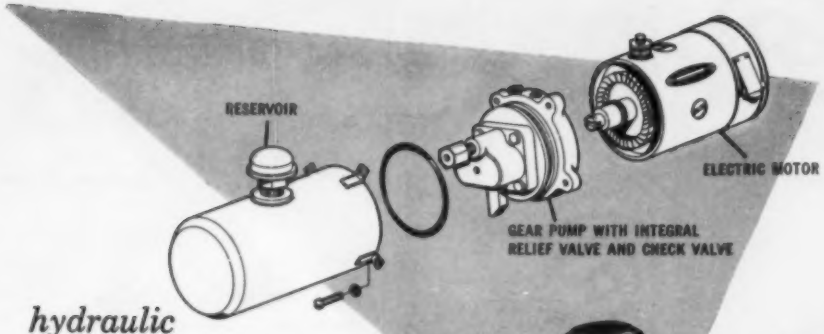
1625 Miller Fluid Power Div.,
Flick-Reedy Corp.
1158 Modernair Corporation
612 Ortman-Miller Machine Co., Inc.
814 Ross Operating Valve Company
1634 A. Schrader's Son Div.,
Scovill Manufacturing Co.
130 Sealol Corporation

1339 Socony Mobil Oil Company, Inc.
322 Standard Pressed Steel Company
640 Sun Oil Company
2019 The Texas Company
1423 The Tomkins-Johnson Company
540 Valvair Corporation,
Sinclair Collins Valve Company
967 Watts Regulator Company

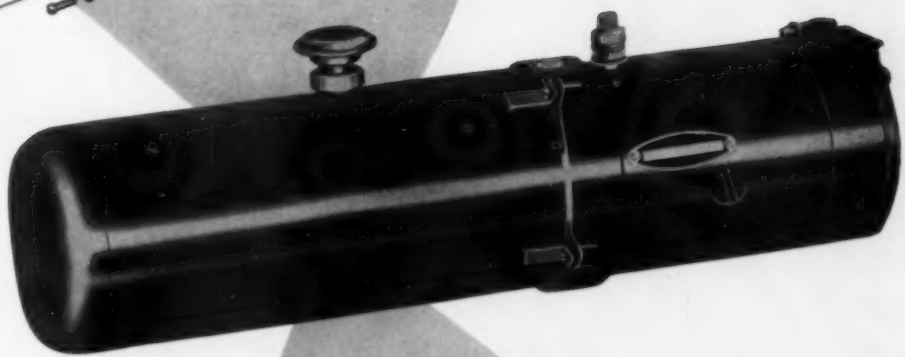
Applied Hydraulics
THE MAGAZINE OF FLUID POWER



nn Engineering Company	1625	Miller Fluid Power Div., Flick-Reedy Corp.	1339 Socony Mobil Oil Company, Inc.
rey Products Div.			322 Standard Pressed Steel Company
l Gas Light Corp.	1158	Modernair Corporation	640 Sun Oil Company
lunt & Son Inc.	612	Ortman-Miller Machine Co., Inc.	2019 The Texas Company
port Machine Co., Inc.	814	Ross Operating Valve Company	1423 The Tomkins-Johnson Company
oducts Inc.	1634	A. Schrader's Son Div., Scovill Manufacturing Co.	540 Valvair Corporation, Sinclair Collins Valve Company
Specialties Company	130	Sealol Corporation	967 Watts Regulator Company



hydraulic power from a 6, 12 or 24-v. source...



Power Package by Wooster is low-cost, self-contained, versatile unit

TRACTORS

SNOW PLOWS

SMALL DUMP BODIES

TAILGATE LOADERS

LIFT TRUCKS

	D-C volts		
	6	12	24
Max. pressure-psi	2000	2000	2000
Capacity—gpm @ 2000 psi	.36	.60	.36
Capacity—gpm @ 1000 psi	.55	.80	.55
Approximate Wt.—lbs.	24	24	24
Electric Motor	Totally enclosed, intermittent duty		

Here's the answer to your problem of producing hydraulic power from an electrical source—the Hydraulic Power Package by Wooster available at a price you can afford. Useful for countless applications, this dependable unit has high quality and a long performance life built into it.

Hydraulic Power Packages by Wooster incorporate an electric motor, hydraulic gear pump with integral relief valve, check valve and reservoir in one, compact assembly. The pump features "Pressure Loaded" bearings, a patented principle which assures higher volumetric efficiency and longer life.

Original equipment manufacturers are invited to obtain price quotations or detailed information. For all industrial hydraulic requirements, pumps, motors and valves as well as power packages—your best source is Wooster Division.

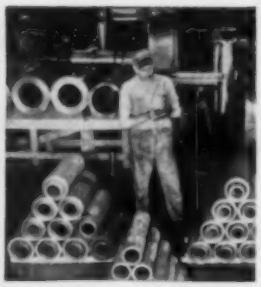
WOOSTER DIVISION
BORG-WARNER CORPORATION
Old Mansfield Road • Wooster, Ohio

WOOSTER

BW

Wooster Sales Offices: CHICAGO—CEntral 6-8980 • DETROIT—UNiversity 2-4712
LOS ANGELES—STate 9-0487 • PHILADELPHIA—WAlnut 5-4020

CIRCLE 150 ON READER SERVICE CARD



You machine better and faster with

SHENANGO CAST BAR STOCK

Because Shenango tubular stock is *centrifugally* cast, impurities and pockets are *forced* out of the metal in the molten stage. Moreover the grain is finer, pressure-dense and more uniform. This results in smoother machining, better control, and less waste of time and metal.

Made of high-strength Meehanite metal or long-lasting bronze, Shenango tubular stock comes in a *complete* range of I.D. and O.D. sizes. Its lengths go up to 20 feet, depending on diameter, which keeps cut-off waste to a minimum.

While the demand for Shenango bar stock is largely tubular . . . solid round, square, hexagonal, rectangular and other special shapes are readily available.

It will pay you to specify Shenango bar stock for longer wear, greater strength, fewer rejects . . . and lower over-all cost. For full information, write to: *The Centrifugally Cast Products Division* of The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

CIRCLE 122 ON READER SERVICE CARD

. . . at Design Show

Booth

585 General Controls Co.

You'll see . . . automatic control including counting devices, switches, electric valves, actuators, relays, limit controls, and time switches which the engineer can use as building blocks for automated fluid powered systems.

CIRCLE 205 ON READER SERVICE CARD

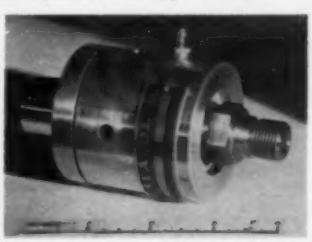
883 The Bellows Company

You'll see . . . a heavy duty air cylinder called the Bellows Bel-Air Cylinder being introduced. Also on display will be the full line of pneumatic devices and hydraulic controls.

CIRCLE 206 ON READER SERVICE CARD

1042 Sealol Corp.

You'll see . . . a new fluid transfer unit designed to withstand pulsating pressures to 1000 psi and speeds to 10,000 rpm. It is particularly adapted for gun-drilling and clutch applications.



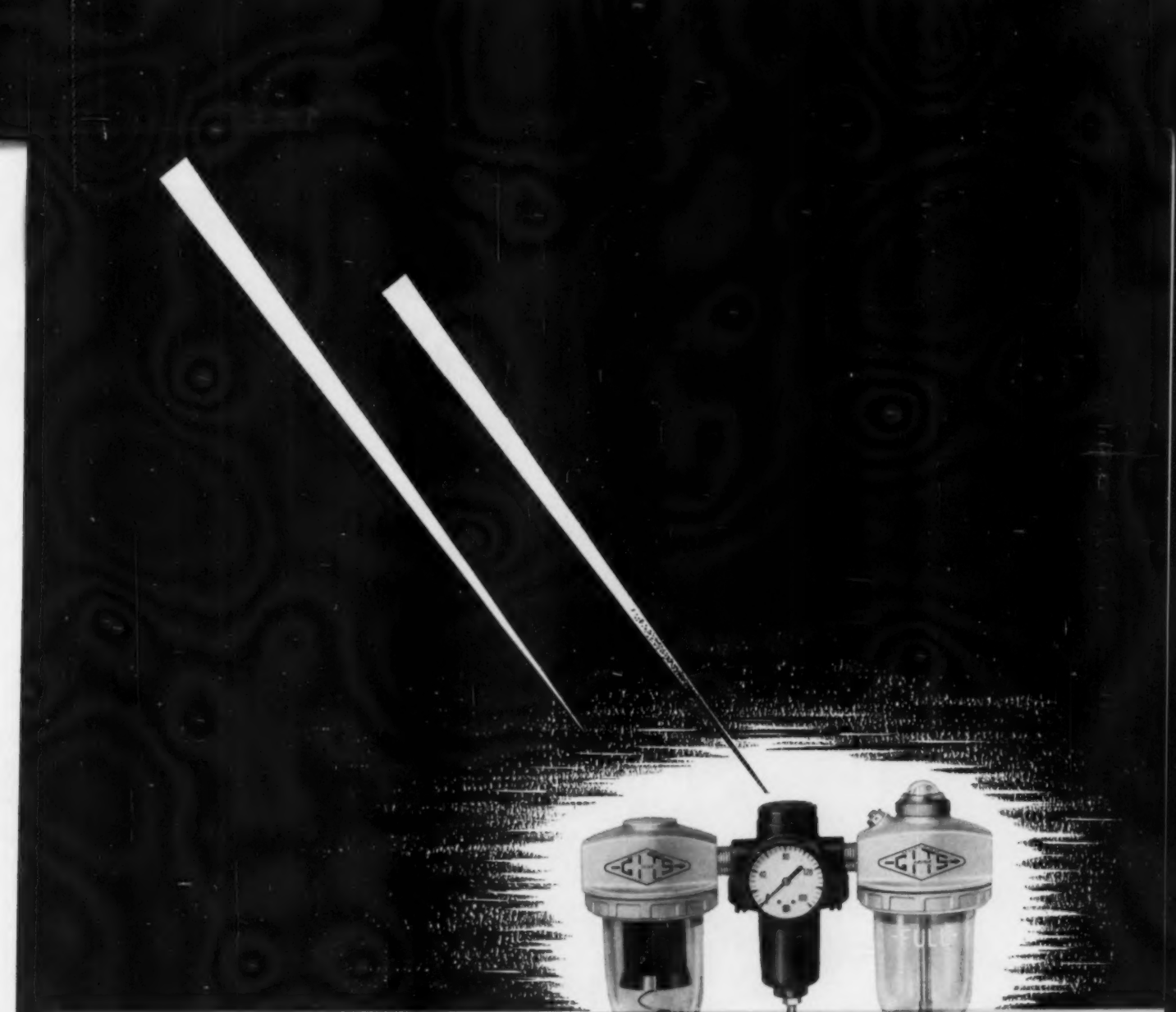
CIRCLE 207 ON READER SERVICE CARD

561 Benton Harbor Engineering Works Inc.

You'll see . . . an extensive line of hydraulic cylinders for working pressures to 3000 psi and bore sizes to 8 in. Cylinders have cup, ring and O-ring type packings.

CIRCLE 208 ON READER SERVICE CARD

CIRCLE 53 →



EXCLUSIVE

GITS MATCHED-SET AIR LINE LUBRICATION

To meet modern industry's growing demand for better air line lubrication, this complete "matched-set" line of Air Line Lubricators, Filters and Regulators offers an exclusive combination of important advantages, including:

REDUCED INVENTORY. Only 1 size handles any air line in the plant up to ¾" pipe size.

INSTANT MONITORING by Gits Mist-a-Dome.

MINIMUM PRESSURE DROP, regardless of volume of air: a result of Gits By-Pass Valve.

FLEXIBILITY. Can lubricate from ¾ to 90 cubic feet of air per minute.

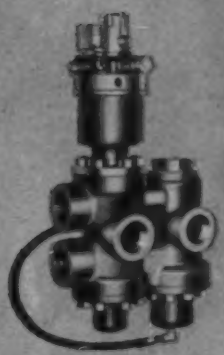
See us at the Design Engineering Show Chicago Amphitheater Booth 838

Get full details. Send for this **NEW FREE CATALOG**

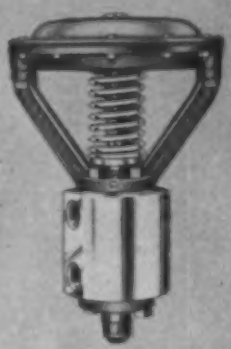
GITS BROS. MFG. CO. *Pneumatics Division*
1846A South Kilbourn Avenue, Chicago 23, Illinois

for push button automatic control . . . faster action . . . trouble-free service . . .

4000 PSI BALANCED 3 WAY VALVE



3000 PSI 4 WAY HYDRAULIC VALVE



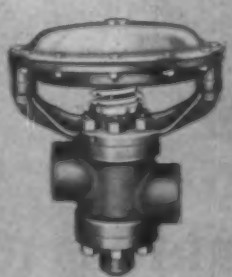
6000 PSI BALANCED 3 WAY VALVE

SPECIFY

SINCLAIR-COLLINS

DIAPHRAGM-OPERATED CONTROL VALVES

2, 3 and 4 way • single or two pressure • high or low pressure — air operated, oil operated • for oil, air, steam, hot or cold water service • remote manual or automated control



4000 PSI 2 WAY VALVE —DIRECT ACTING —NORMALLY OPEN TYPE

4000 PSI 2 PRESSURE, HYDRAULIC OPERATING VALVE—AUTOMATIC HIGH PRESSURE

Any rubber or plastic processing equipment you manufacture or operate will perform better—at lower cost—with Sinclair-Collins valves!

Shockless inlet and release pressures, Stellite valve stem seats, replaceable hardened stainless steel seat sleeves, cast navy bronze (4000 psi) or hi-tensile bronze alloy billet (6000 psi) valve bodies which resist the corrosive action of water and high velocity hydraulic fluids . . . all these features add up to peak, trouble-free performance and lower maintenance costs!

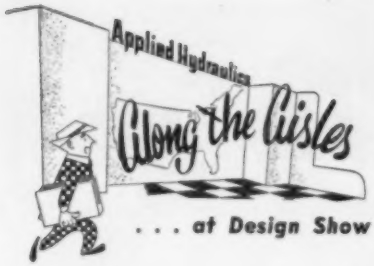
Consider your high pressure valve requirements carefully. Then call in your nearby Sinclair-Collins representative. You'll find that he can supply your valve needs *exactly* . . . in sizes from ½ to 3 in. . . . all available for fast delivery from stock. Write for brochure. The Sinclair-Collins Valve Company, 454 Morgan Avenue, Akron 11, O.

AA-6189

Representatives in principal cities

THE SINCLAIR-COLLINS VALVE COMPANY

454 Morgan Avenue • Akron 11, Ohio



Booth

628 Superior Tube Co.

You'll see . . . a complete line of low carbon steel hydraulic tubing meeting all JIC and SAE specifications. Tubing is seamless and recommended for pressures to 3000 psi.

CIRCLE 209 ON READER SERVICE CARD

938 Titeflex Inc.

You'll see . . . the new 140 series Teflon hose with detachable and reusable industrial fittings. The fittings consist of three parts, a compression nut, a tapered ring and a nipple insert.

CIRCLE 210 ON READER SERVICE CARD

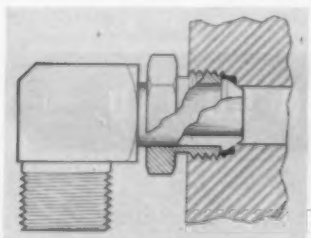
1033 The Cuno Engineering Corp.

You'll see . . . a display of fluid filters for capacities to 2000 gpm. They are made in the edge-type, fibre cartridge, porous metal, and sintered screen type elements. Filters can be furnished for particle removal to one micron.

CIRCLE 211 ON READER SERVICE CARD

1029 Flodar Corp.

You'll see . . . a complete line of high pressure hydraulic fittings featuring a metal-to-metal seal. Fittings incorporate a captive nut which allows them to be positioned accurately before tightening.



CIRCLE 212 ON READER SERVICE CARD

4 Years of Proof in the Field...
Positive evidence of the advantages of "MEMORIZED"
TEFLON*
for
Cylinder Packing
Style 310 Piston Cups
Style 210 Flange Seals
Style 614 V Rings
Style 410 U Cups and Blocked Vees
also other hydraulic specialties
. . . "O" Rings, Single Turn Back-up Rings, Step-joint Piston Rings
SINCE 1953, HALOGEN cylinder packing has successfully operated over the widest temperature and pressure ranges in the hydraulic field . . . BECAUSE THEY ARE "MEMORIZED."
. . . "MEMORIZED" . . . an EXCLUSIVE process which makes the packing lip "remember" the size of the rod or cylinder . . . and keeps it in sealing position . . . regardless of temperature variations.
You haven't used the ultimate in TEFLON packing until you've tried the FIELD PROVEN AND ENGINEERED "TEFLON by HALOGEN." Investigate now . . . send your prints for assembly details.
* TEFLON — du Pont trademark
HALOGEN HANDBOOK
Write for HALOGEN'S "Hydraulic Handbook"
HALOGEN
INSULATOR & SEAL CORP.
10121 Franklin Ave., Franklin Park, Ill.
Engineers and Manufacturers — TEFLON Products

CIRCLE 59 ON READER SERVICE CARD

TYPE 11 P

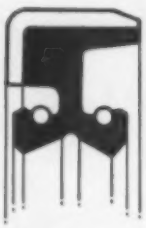
The standard rotary shaft seal. Gives perfect sealing at high speeds and for long periods, with minimum frictional loss.

TYPE 11 P/B

As type 11 P but with the casing covered with rubber. Interchangeable with metal case seals.

TYPE 23 P

An external seal used when fitting conditions prevent the use of 11 P or 11 P/B seals.



TYPE 12 P

A rotary shaft seal used to separate two different fluids.

TYPE 13 P

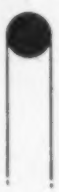
Similar to type 12 P but without a spring on the second lip which serves as a dust excluder.

TYPE 31 P

A springless seal used as a wiper or dust excluder for rotating or reciprocating shafts.

NU-LIP RINGS

A special section ring which cannot twist. Superior to the O-ring for low and medium pressure non-static applications.



O-RINGS

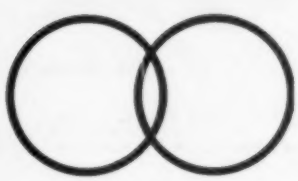
A compact automatic seal for reciprocating and static applications over a wide range of temperatures and pressures. All British Standard sizes in stock.

TYPE 7 P

A hydraulic and pneumatic seal used chiefly on reciprocating pistons or as a valve stem packing. Normally fitted in a groove.

PIONEER OILSEALS O-RINGS AND HYDRAULIC PACKINGS

Every fluid sealing application comes within the Pioneer range. Write NOW for the PIONEER OILSEAL LITERATURE.

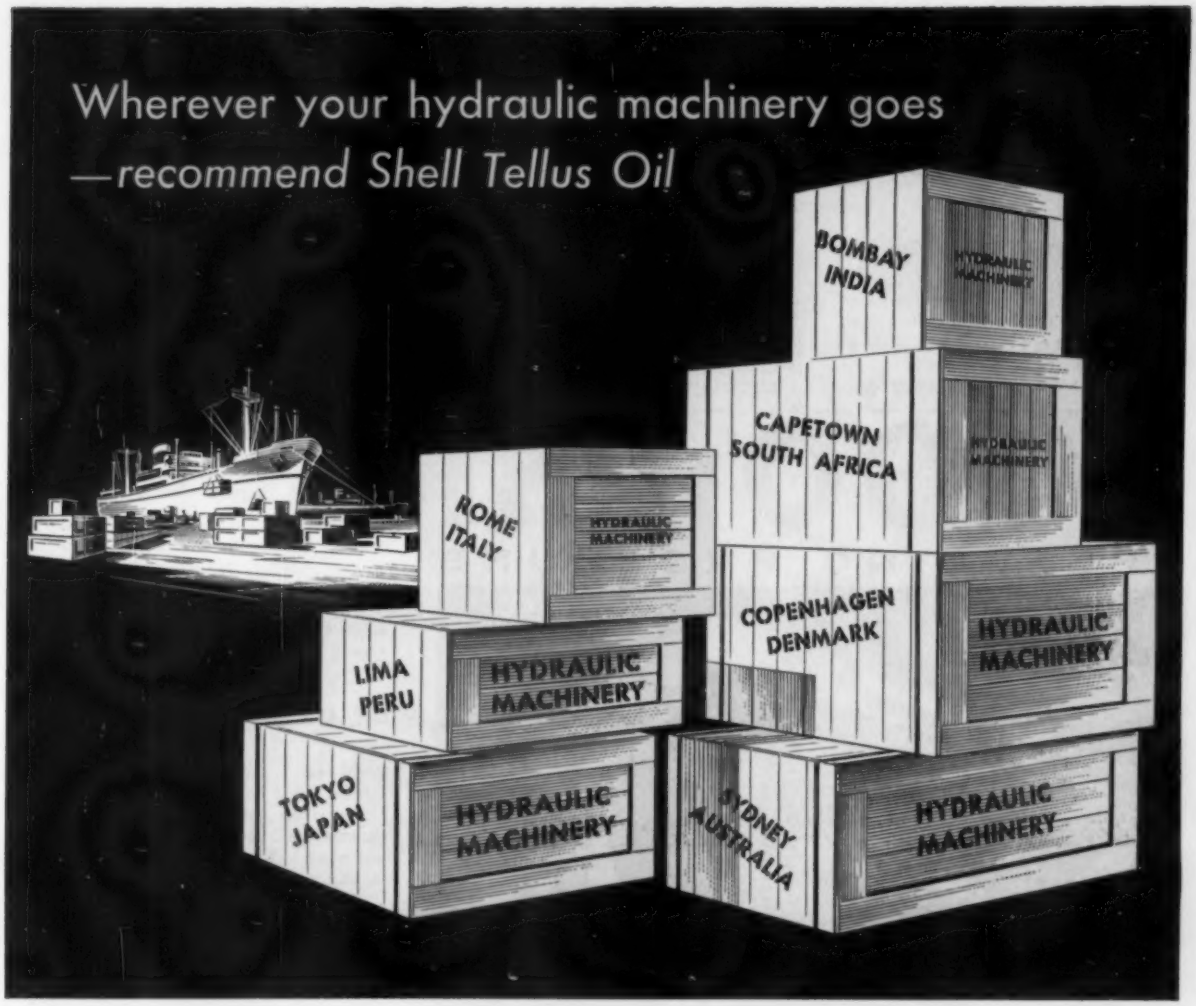


PIONEER OILSEALING & MOULDING CO. LTD.

A DIVISION OF J. H. FENNER & CO. LTD

Factory and Head Office: Cottontree Works, Colne, Lancs, England. Tel. Wycoller 471 (8 lines).

CIRCLE 102 ON READER SERVICE CARD



Its performance and name are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

Shell Tellus Oil is top-rated as both a lubricant and a control fluid for complex hydraulic systems. Its ability to combat oxidation, rust, sludge-formation, wear and foaming has earned it nationwide popularity.

You may be glad to know that the hydraulic-operated equipment you manufacture can now obtain the same efficient protection in other countries of the world. Tellus* Oil is available to your customers abroad. With it they can enjoy the same performance that your domestic customers rely upon.

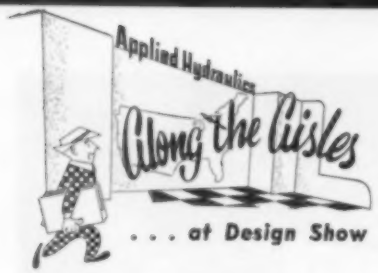
For more complete information on Tellus Oil, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

*Registered Trademark

SHELL TELLUS OIL

SHELL

CIRCLE 121 ON READER SERVICE CARD



Booth

940 Skinner Electric Valve Div.

You'll see . . . a new 2-way solenoid valve that combines large orifice capacity with high pressure differential. Valve is pilot operated and will handle air, water or oil at pressures to 200 psi.

CIRCLE 213 ON READER SERVICE CARD

950 E. F. Houghton and Co.

You'll see . . . a complete line of hydraulic fluids and packings including water-base and phosphate ester fire-resistant fluids. A special display will feature the full compatibility of Houghton fluids and packings.

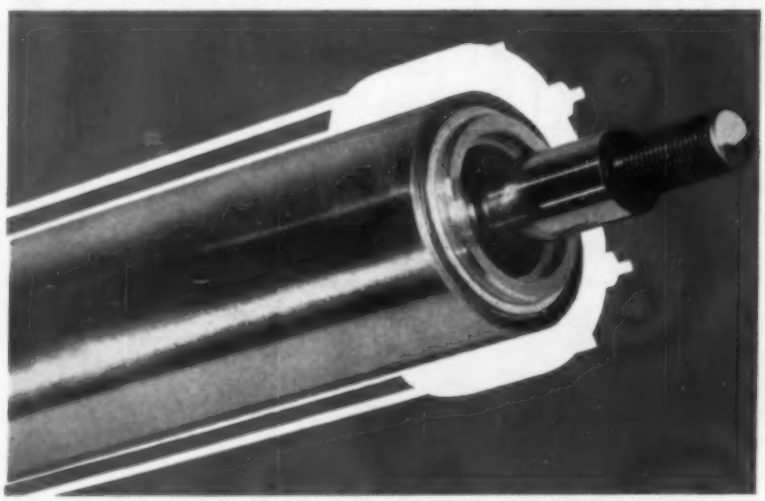
CIRCLE 214 ON READER SERVICE CARD

212 U. S. Electrical Motors Inc.

You'll see . . . a pneumatic control system that provides controlled variable speed for fans or pumps in a heat exchanger circuit. System will hold temperature output within 1% of setting.

CIRCLE 215 ON READER SERVICE CARD

3000 PSI
OPERATING PRESSURE



UP TO 50% LESS SPACE, WEIGHT & COST

Sleek, powerful DECCTO Cylinders, with exclusive Bruning-ized "Black Mirror" bores, save space, weight and cost in any application. AVAILABLE in bore diameters from 1½" to 4", plus a "Pee Wee" series from ⅜" to 1¼" . . . with innumerable mounting configurations. NO tie rods, NO castings, NO bolts, NO screws! Disassembly or reassembly takes less than 30 seconds. Qualified and Specified as "Standard Original Equipment" on thousands of applications ranging from hypersensitive missile control systems to heavy duty industrial, automotive and military ordinance installations. DECCTO cylinders are competitively priced . . . with FAST DELIVERY!

DECCTO

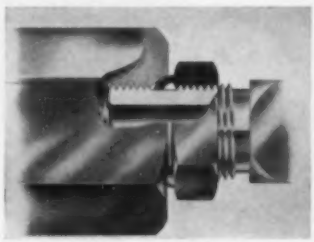
for specifications, prices, test samples . . . contact—

the Bruning COMPANY

P. O. BOX 147 LINCOLN NEBRASKA

438 L & L Manufacturing Company

You'll see . . . this company's straight thread metal-to-metal seal fitting. The "captive nut" design will be tested on a working model display.



CIRCLE 216 ON READER SERVICE CARD

301 Eagle Signal Corp.

You'll see . . . three new automatic timers shown for the first time. One is an add-subtract counter operated by electrical pulses fed to the unit. Counter was designed for conveyor systems and inventory control.

CIRCLE 217 ON READER SERVICE CARD

481, 483, 485 Automatic Switch Co.

You'll see . . . a new 2-way high pressure solenoid valve designed for 1500 psi hydraulic service. It is internal pilot operated and is available with stainless steel or brass body. Sizes ½ and ¾ in.

CIRCLE 218 ON READER SERVICE CARD

846 Air-Maze Corp.

You'll see . . . a cleanable micronic liquid filter constructed of wire mesh arranged in the form of multiple discs. This construction gives a large effective filtering area.

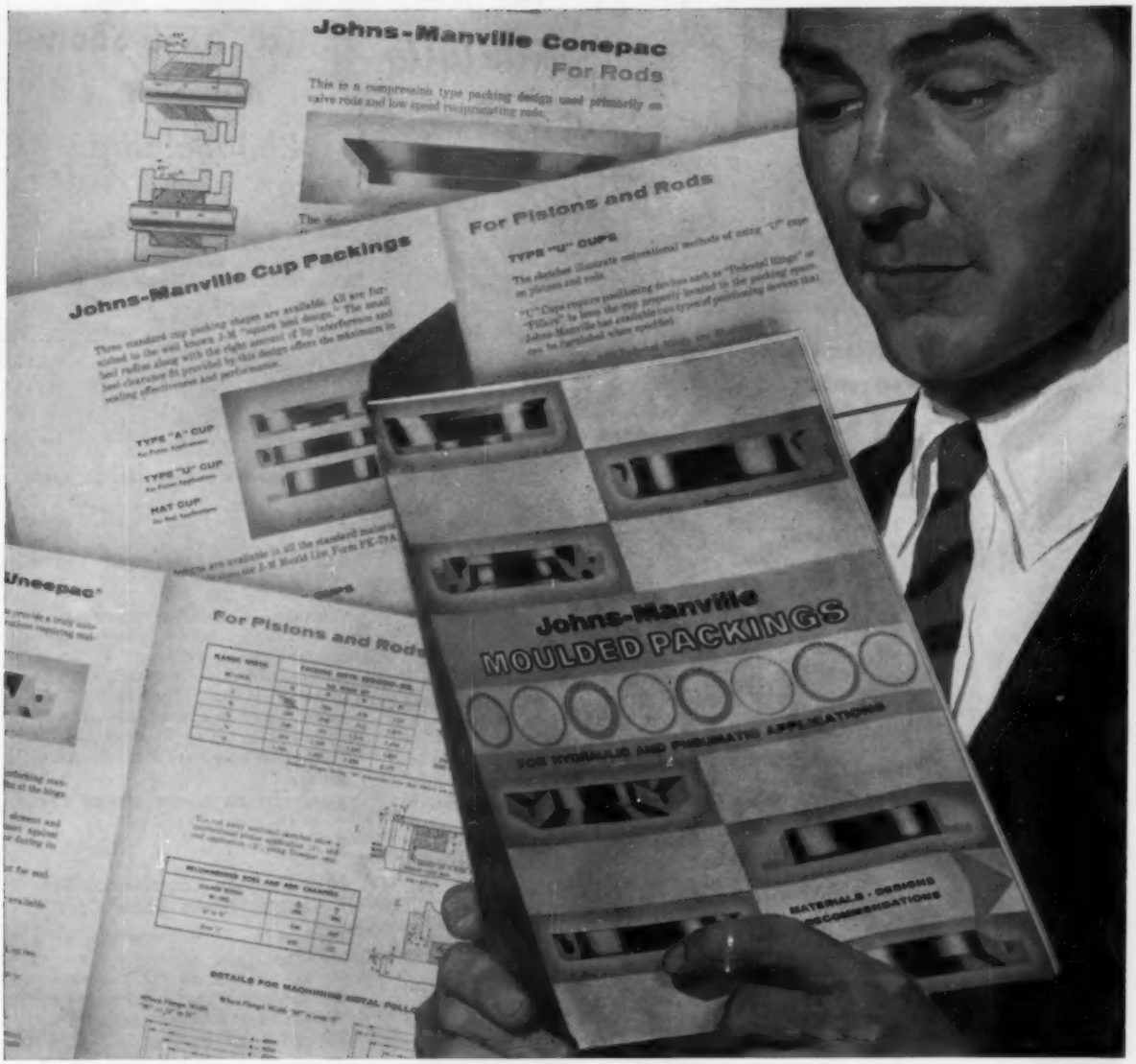
CIRCLE 219 ON READER SERVICE CARD

555 Crane Packing Co.

You'll see . . . a display of piston cup, U cup, and flange packings. They are made of Teflon and are designed for high pressure hydraulic cylinders. Packings are ideal for use with non-flammable hydraulic fluids.

CIRCLE 220 ON READER SERVICE CARD

CIRCLE 27 ON READER SERVICE CARD



Now...in handy, concise form

Design Data and Application Hints on J-M Moulded Packings

Here's a "must" for your reference file—Johns-Manville's helpful, new Moulded Packings brochure. Designed to offer you complete engineering details on packings for hydraulic and pneumatic applications in handy, condensed form, this booklet is packed with the data you need most at every stage of planning and design.

In this compact handbook you'll find data on Johns-Manville Packings for pistons and rods—including cups, Uneepac® Rings, V-Rings and Sea® Rings, Cumpac®, and Conepac. Data on pressure and temperature ranges and information on packing materials are also included.

Easy-to-read drawings show you complete packing and stuffing box details and information on follower ring designs. Operating characteristics and required accessories are spelled out to assist you in evaluating each packing for your application.

MAIL COUPON TODAY for your free copy of this informative brochure.

Johns-Manville, Box 14, New Yo. k, N.Y.
Please send me your new, free brochure on Moulded Packings, PK-126A.

Name_____
Title_____
Company_____
Address_____
City_____
Zone_____ State_____

JOHNS-MANVILLE

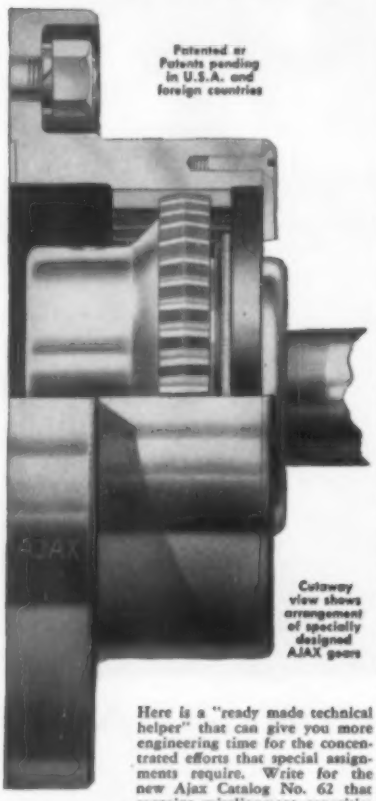
JM PRODUCTS

AJAX

Self-aligning

DIHEDRAL COUPLINGS

Short Cut to Major Product Improvement



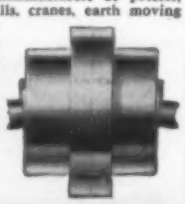
Patented or Patents pending in U.S.A. and foreign countries

Cutaway view shows arrangement of specially designed AJAX gears

Here is a "ready made technical helper" that can give you more engineering time for the concentrated efforts that special assignments require. Write for the new Ajax Catalog No. 62 that contains misalignment capacities of every coupling size and type in the complete line of Ajax Dihedral Couplings. Why spend valuable time duplicating data already established by thousands of proven, field tested applications.

Ajax Dihedral Couplings handle unavoidable shaft misalignment, angular and offset, up to a total of 12°. Teeth can be cut to handle greater misalignment capacities on special order.

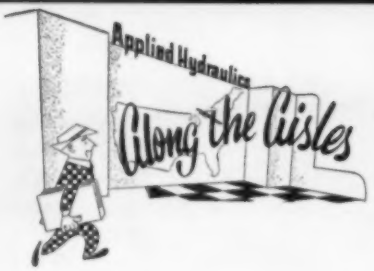
Get the facts on how manufacturers of presses, machine tools, rolling mills, cranes, earth moving and many other direct connected machines are simplifying design, cutting manufacturing costs and improving product performance with Ajax Dihedral Couplings.



Write today for your personal copy of Bulletin No. 62.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

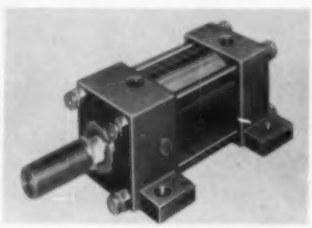
CIRCLE 7 ON READER SERVICE CARD



. . . at ASTE Show May 1-8 Philadelphia

Booth
1652 & 1656 Logansport Machine Co. Inc.

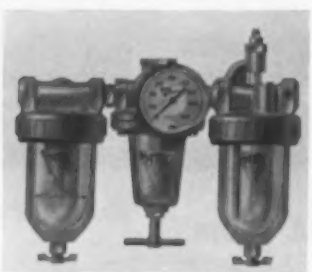
You'll see . . . the new line of air cylinders, Series 50,000, which was designed to meet the specifications of the automotive industry. Also on display will be their complete line of valves, cylinders, power units, power chucks, air vises, and small presses.



CIRCLE 221 ON READER SERVICE CARD

967 Watts Regulator Co.

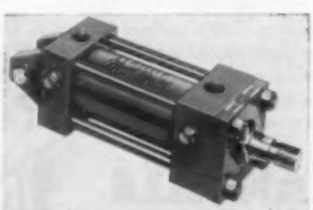
You'll see . . . air line filters, lubricators and regulators. The lubricators feature a small venturi section which provides lubrication at low flows and a by-pass valve which provides lubrication at high flow rates.



CIRCLE 222 ON READER SERVICE CARD

713 Hanna Engineering Works

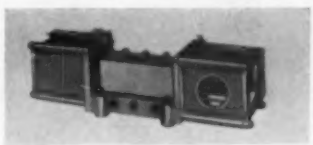
You'll see . . . a new line of 2000 psi hydraulic cylinders called the Powr-draulic series. They have 13 basic mounting styles and a choice of rod sizes for each bore. This will permit a standard cylinder to be supplied for most all applications.



CIRCLE 223 ON READER SERVICE CARD

529 C. B. Hunt & Son Inc.

You'll see . . . two control valves, the BJ series and the CJ series. Both valves conforming to JIC standards.



CIRCLE 224 ON READER SERVICE CARD

818-814 Ross Operating Valve Co.

You'll see . . . a variety of new models in the Skyline series. Many of them connected to an air supply to demonstrate actual on-the-job conditions. One of the valves featured will be the Silver Model, which is a spool solenoid pilot valve conforming to JIC standards. The valve has been tested to 25 million cycles.

CIRCLE 225 ON READER SERVICE CARD

1012 Denison Engineering Div., American Brake Shoe Co.

You'll see . . . a new line of pilot-operated, solenoid controlled 4-way valves, meeting all JIC requirements and designed to provide all porting and positioning arrangements on circuits to 3000 psi.

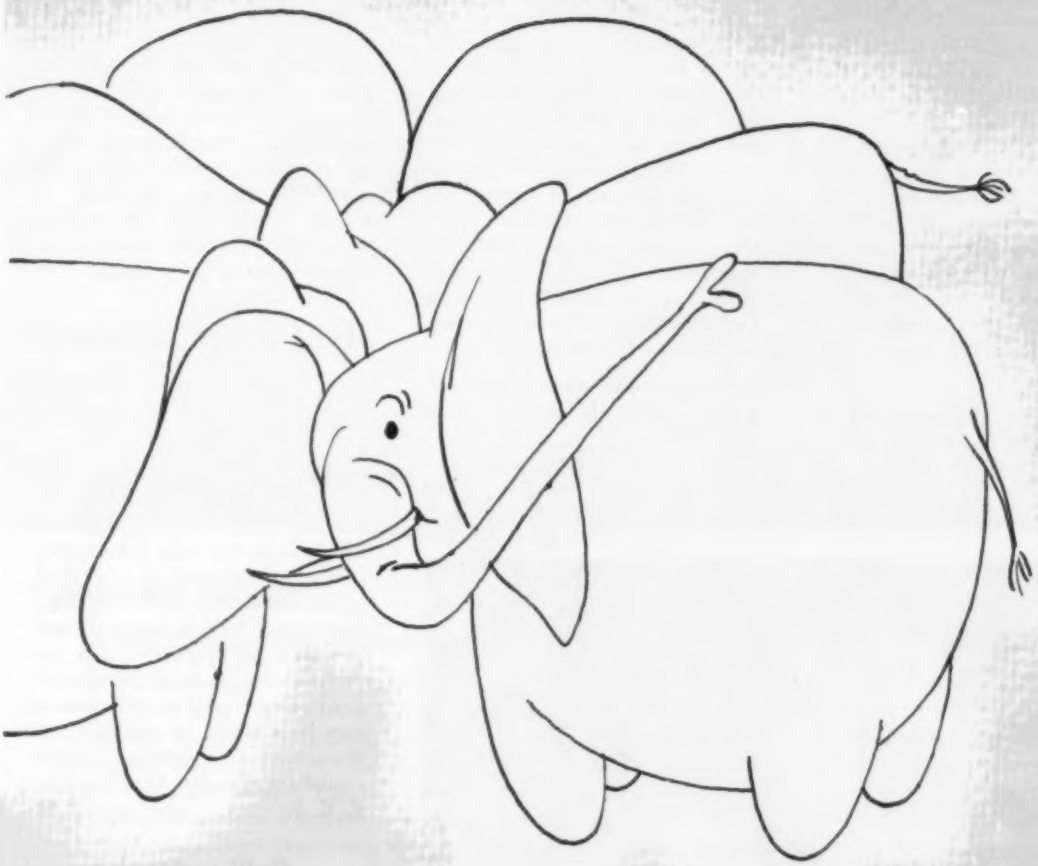
CIRCLE 226 ON READER SERVICE CARD

1158 Modernair Corp.

You'll see . . . a line of Veri-trol cylinders which is a hydraulic cylinder used in connection with an air cylinder to uniformly control the stroke. Speed control is dial-set, and is load compensated to give uniform feed under changing loads.

CIRCLE 227 ON READER SERVICE CARD

something big on the move



ANOTHER ENGINEERING FIRST FROM TJ TOMKINS-JOHNSON

Don't Miss It at the ASTE Show, May 1-8, Booth 1423

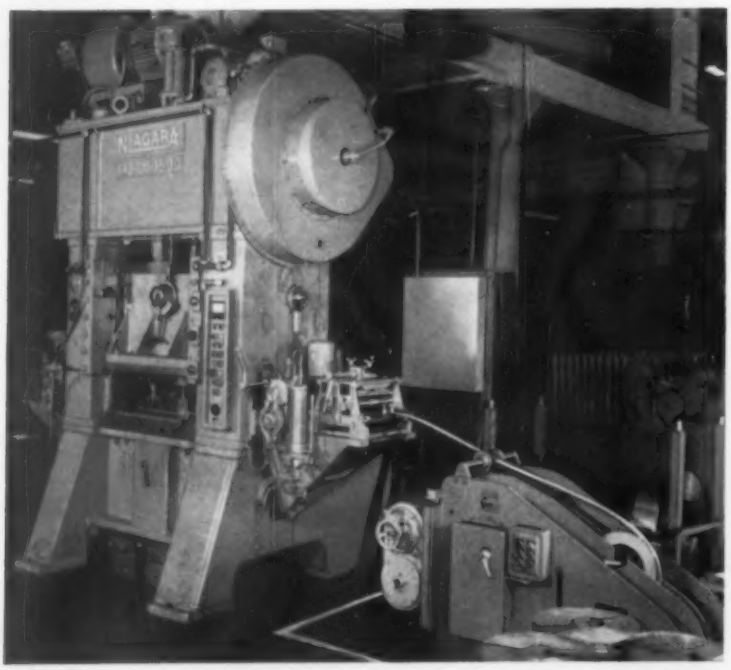
BRIEFS about fluid power

AIR CONTROLS 300 TON PRESS

• **Air operated clutch**—The new high production presses known as the Series SA-2 Automatic, now being built by Niagara Machine & Tool Works, Buffalo, New York, use electro-pneumatic clutches to control slide motion. The friction clutch operates directly on the crankshaft. There are no gears nor high speed shafts to start or stop at each engagement. Operating controls incorporate the latest safe-guards against injury to personnel and damage to the press.

• **Air operated brake**—An air operated brake operates in conjunction with the clutch. A spring applies the brake and air pressure releases it. Clutch and brake cannot buck each other. A single solenoid valve controls the air to both. Air pressure builds up to overcome the clutch spring, thus engaging the clutch and, at the same time, overcoming the brake spring, thereby releasing the brake. The built in proportionality between the clutch air-cylinder diameter compared with its spring, and the brake air-cylinder compared with its spring, is such that the brake is released when the clutch engages.

• **Air pressure supply**—Compressed air to the control circuit passes through an air control manifold. The manifold contains a regulator, check valve, shut-off valve, blow down valve and pressure gage. The torque output of the clutch can be vaied over a range by variation of the regulated pressure. To prevent abnormal wear on the clutch friction discs, which would occur if the operating air pressure should drop below normal limits, a surge tank is placed in the clutch air supply. Momentary drops in pressure are absorbed by the surge tank. ▼▼▼



Fluid Power Conference In Europe

Compressed Air & Hydraulics (An English trade journal) is presenting a Fluid Power Conference in London, England on May 14 and 15, 1958. Subjects discussed will include, low cost automation, current developments in fluid power equipment, servo mechanism control, high pressure air and low pressure hydraulics, and application of research to specific problems. Further information may be obtained by writing Compressed Air & Hydraulics, Temple Chambers, Temple Ave., London, E. C. 4. ▼▼▼

Rolling Steel Takes Air, Oil, Water

It takes elaborate piping to deliver hydraulic oil, and air to a modern sheet rolling mill.

For one of the fastest and heaviest sheet mills in the steel industry, rolling sheet steel at 40 miles an hour, Blaw-Knox Company's Power Piping and Sprinkler Division recently engineered and in-

Continued on page 52

Champion performance in a fist-sized pump...sealed by C/R

THE PROBLEM:

To seal a rotary pump handling a wide range of fluid viscosities, pressures and temperatures

These pumps are performing dependably in hundreds of different hydraulic applications. They handle any fluid with lubricating qualities . . . deliver up to 180 gph, and maintain high volumetric efficiency even with low viscosity fluids. This particular pump also carries Underwriters' Laboratories approval for use in oil burners. For dependable sealing, C/R's Type HMS Oil Seal was chosen. It performs effectively from 28" Hg to 5 psi, and from 50 to 8000 rpm. This is only one of the thousands of ways in which C/R Oil Seals and engineering are solving difficult sealing problems throughout industry. C/R engineers can help you, too—especially where critical conditions exist. A letter or telephone call will get them started for you. Write for your copy of the catalog, "C/R OIL SEALS."

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY
1203 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Hamilton, Ontario.
Export Sales: Geon International Corp., Great Neck, New York

C/R PRODUCTS: C/R Shaft and End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

C/R OIL SEAL DIVISION
CHICAGO RAWHIDE

in low-compression-set Butyl . . . for sealing problems involving the non-flammable phosphate esters.

LINEAR . . . specialists in close tolerance molding in all of today's elastomers.

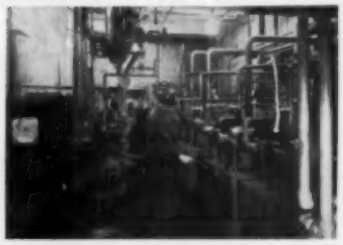
Call on LINEAR for assistance with all your seal problems.

PERFECTION IN RUBBER
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

BRIEFS

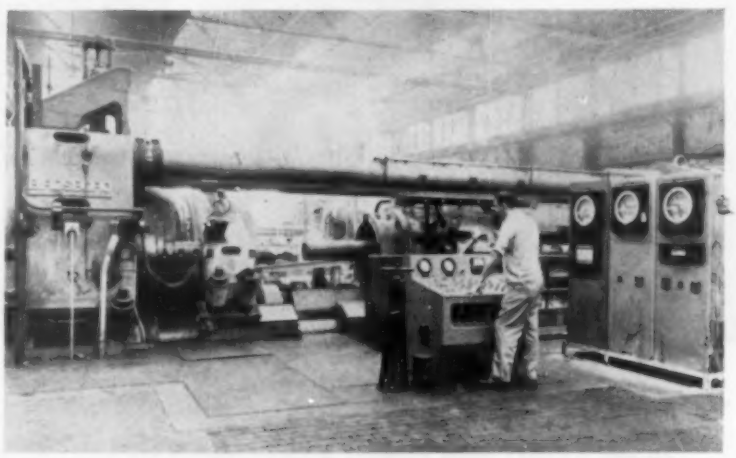
stalled a very complex, yet compact and accessible automatic piping systems. Everything but water is delivered to points of use from storage tanks in the basement.

The hydraulic and pneumatic systems are the most colorful in spite of being the least seen. System identification requires the use of all colors of the rainbow plus black, gray and aluminum to distinguish the 3500-psi hydraulic system for maintaining roll balance, a 1000-psi hydraulic system for operating mill controls, and a compressed air system. Lubricating oil systems, pressure grease systems, and an oil emulsion are also color coated coolant systems.



All of these systems are fully automatic and require no attention except occasional adjustments to assure continuous, trouble-free operation. ▼▼▼

First Automatic Water-Hydraulic Press



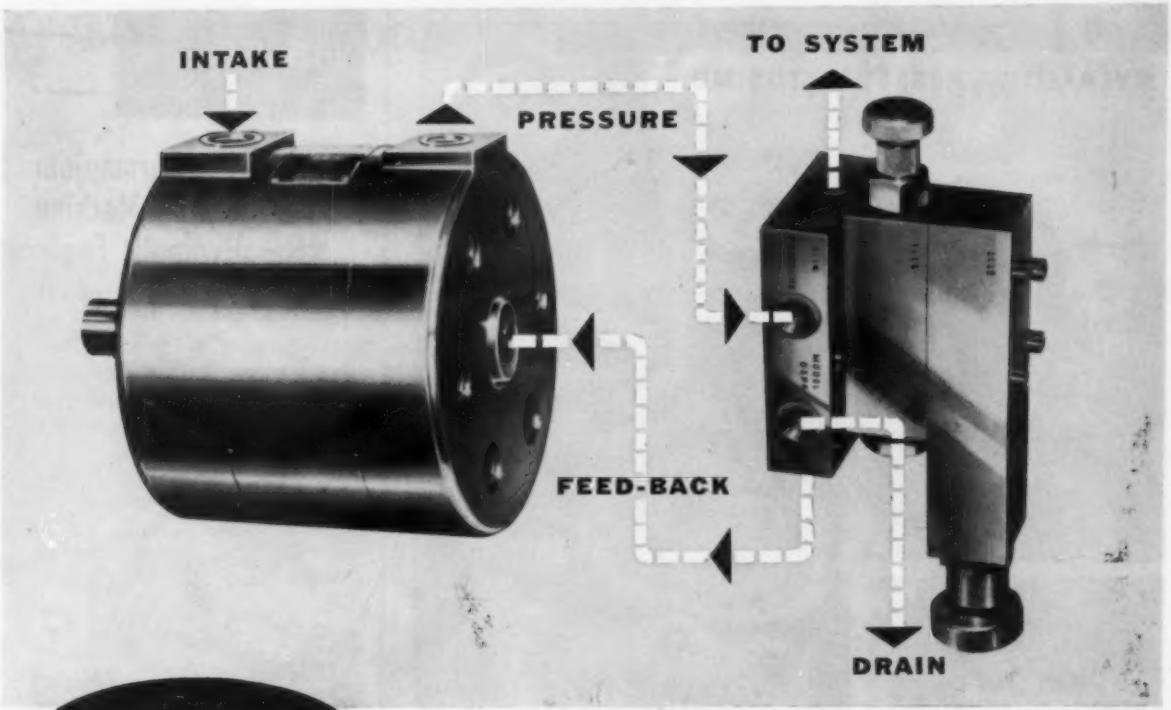
Kaiser Aluminum & Chemical Corp. has installed an automatically sequenced water-hydraulic extrusion press. The equipment was designed and built by Birdsboro Steel Foundry & Machine Co., Birdsboro, Penn., to extrude aluminum tube sizes and assorted shapes nine to twelve inches in diameter and up to thirty-six inches in length.

Operation—Main ram of the press exerts up to 3500 tons and maximum force of the mandrel piercer is 250 tons. The ram, mandrel piercer, container, gate locks and shear are operated by water at 4250 psi. The billet loader and die carrier are oil hydraulically operated at 750 psi.

Control—The press can be operated automatically or manually. It can be run on automatic cycle up to any desired point in the process and then operated manually; the desired switchover point from automatic to manual operation, or vice versa, can be pre-selected by selector switches in the control pulpit.

Automatic cycle control for the movement of the main moving crosshead is built-in. Using a water operated oil hydraulic servo system, it controls the main ram fast advance, the extrusion stroke and the return to starting position. All elements of the press are automatically controlled by two electrical circuits which energize and de-energize solenoid operated valves through limit switches. These, in turn, actuate the main hydraulic valves controlling machine motions. ▼▼▼

Continued on page 54



SECO

VARIABLE DISPLACEMENT

radial piston pump*

UTILIZES THE NEW "*PULSE GENERATION*" TECHNIQUE

Displacement of this radial piston pump is varied by a unique pressure feed-back (pat. pending) principle. The control valve governing feed-back may be remotely located. Due to inherent simplicity of design, this pump and its control valve provide a *low cost* variable displacement system that equals or *surpasses* the performance of more costly conventional variable displacement machines. As compared to *fixed* displacement pumps and controls, horsepower savings are high—as much as 85%.

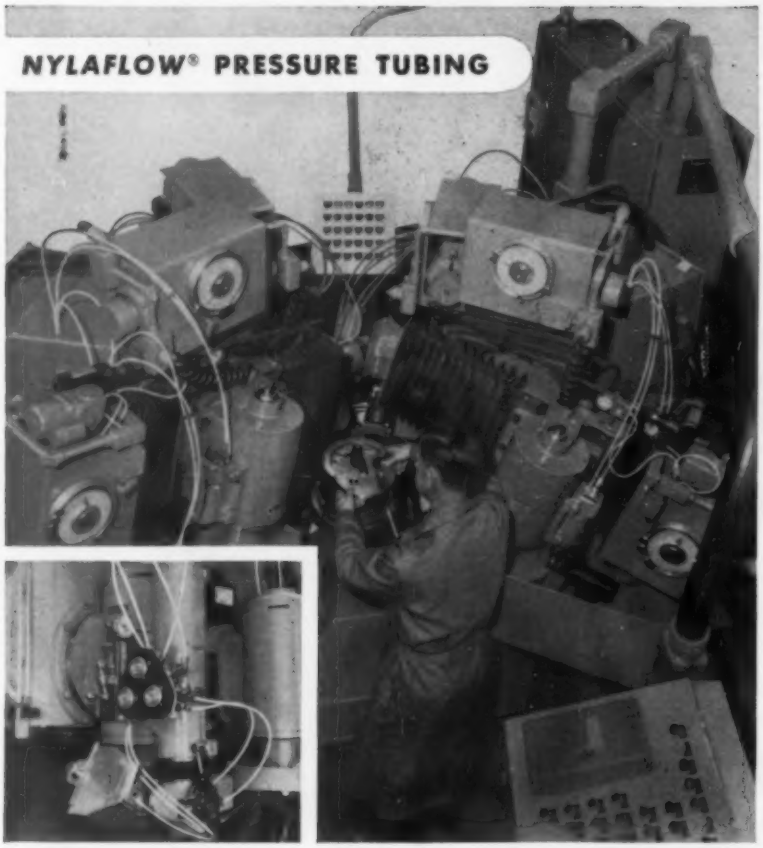
The standard SECO D5PF control valve permits adjustment to a constant pressure regardless of flow demands, or a constant flow regardless of pressure—within the capacity of the pump. The D-5 pump illustrated delivers 0 to 5 G.P.M., and the pressure is adjustable from 200 to 2,000 PSI. For a wide variety of applications this pump is ideal.

*U.S. Pat. No. 2,786,424

SECO
FLUID POWER

SIMPLEX ENGINEERING CO.
Subsidiary of RACINE HYDRAULICS & MACHINERY, INC.
ZANESVILLE, OHIO

CIRCLE 123 ON READER SERVICE CARD



Machine tool designers solve hydraulic tubing problems with flexible *NYLAFLOW*

• Parts and components selected by machine tool builders must meet the strictest specifications and performance requirements. POLYPENCO® Nylaflow Pressure Tubing was chosen for the hydraulic wheel dressers and compensator units of the grinder shown above for these important reasons:

high strength (pressurized at 500 psi) with relatively small size and light weight

retains form—does not sag and foul machine controls

ease of handling

savings in installation

use of standard fittings

• *NYLAFLOW* Pressure Tubing is a tough, flexible polyamide tubing with this unique combination of performance characteristics:

- **High pressure rating at low cost**
- **High resistance to flex and vibrational fatigue**
- **Mechanically strong—resists abrasion and impact**
- **Corrosion and chemical resistance**
- **Serves wide temperature range: as low as —100°F., up to +225°F.**
- **Will not embrittle in storage**

• Available in two short time burst pressure ratings—1000 psi (Type T) and 2500 psi (Type H) O.D. sizes ⅛", 5/32", ¼", 5/16", ⅜".

Information on characteristics, properties, applications, tubing accessories and installation tools is outlined in new NYLAFLOW Bulletin. Write for your copy today.

Visit Polymer Booth #653
Design Engineering Show
Chicago—April 14-17

The POLYMER Corporation of Penna.
Reading, Pa.

Export: Polypenco, Inc., Reading, Penna., U.S.A.

POLYPENCO

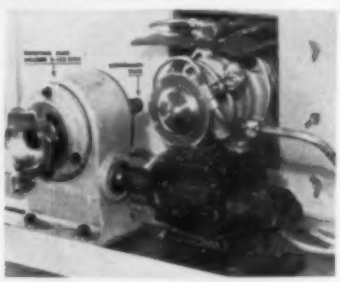
POLYPENCO Nylon, POLYPENCO Teflon†, NYLAFLOW, NYLATRON® GS †DU PONT TRADEMARK

BRIEFS

Germanium Slicing Machine Uses Hydraulic Feed

In order to obtain the smooth travel that is needed for slicing brittle germanium hydraulic feeds have been used on a newly announced machine. The machine is built by Reid Brothers Company, Inc. of Beverly, Mass.

• **Feeds**—The hydraulically operated table provides feeds as



fine as 1/64 nich per minute and cutting speeds from 1/64 to 4 inches per minute. The rapid transfer return is 6 feet per minute.

• **Operation**—The germanium slug to be sliced is held in a rotating holder. The rotating holder is driven by fluid motor over a speed range from 5 to 120 rpm. The cutting wheel is driven by an electric motor at speeds between 5000 and 20,000 rpm. The machine will slice slugs up to 2 inches diameter and up to 6 inches in length. ▼▼▼

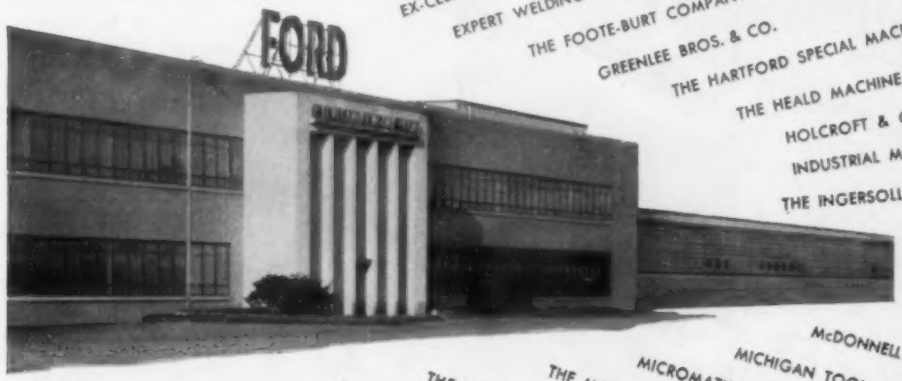
To receive a copy of
THE FLUID POWER PRIZE PAPER
RULES BOOKLET
Circle 240 on Reader Service Card

Damp Surges With A Piston Accumulator

Illustration shows a portion of a solenoid-controlled, pilot-operated directional control valve circuit installed on a production test

Continued on page 56

At The Ford Motor Company's Cleveland Engine Plant No. 1

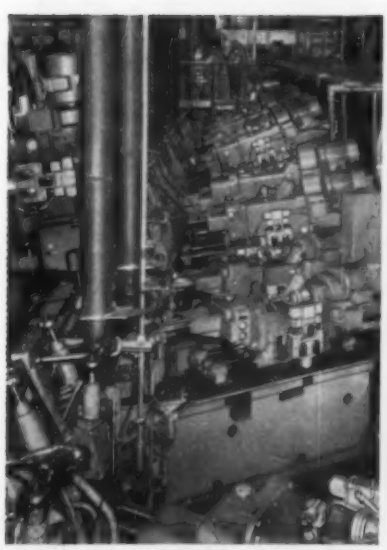


AMERICAN BROACH & MACHINE DIVISION
BARNES DRILL COMPANY
BUHR MACHINE TOOL COMPANY
THE CROSS COMPANY
EX-CELL-O CORPORATION
EXPERT WELDING MACHINE CO.
THE FOOTE-BURT COMPANY
GREENLEE BROS. & CO.
THE HARTFORD SPECIAL MACHINERY CO.
THE HEALD MACHINE COMPANY
HOLCROFT & COMPANY
INDUSTRIAL METAL PRODUCTS CORPORATION
THE INGERSOLL MILLING MACHINE COMPANY
THE LAPOINTE MACHINE TOOL COMPANY
LANDIS TOOL COMPANY
THE R. K. LE BLOND MACHINE TOOL CO.
McDONNELL MACHINE TOOL, INC.
MICHIGAN TOOL COMPANY
MICROMATIC HONE CORPORATION
THE MORRIS MACHINE TOOL CO.
THE MOTCH & MERRYWEATHER MACHINERY CO.
NATIONAL AUTOMATIC TOOL CO.
SNYDER TOOL & ENGINEERING CO.
SUNDSTRAND MACHINE TOOL CO.
WICKES MACHINE TOOL DIVISION
WILSON AUTOMATION COMPANY

See our Exhibit in BOOTH 768 at the Design Engineering Show

VICKERS HYDRAULICS

HELPS CUT MAINTENANCE COSTS of Machinery Supplied by These Companies to This Modern Automated Plant



Typical transfer line installation shows ample use of Vickers hydraulics for actuation and control of automated operations.

High production is convincing proof of equipment reliability—one of many reasons why Vickers Hydraulics is engineered into equipment for modern automated production plants.

The above manufacturers find that Vickers Hydraulics simplifies installation and minimizes piping—benefits also enjoyed by the user. Vickers highly efficient pumps produce significant power savings . . . Vickers controls help minimize scrap and rework by providing precise positioning for machining and other in-process operations. Component dependability helps provide extended periods of uninterrupted production. Demountable unit construction simplifies on-the-job repairs and helps reduce downtime.

The Vickers complete line of components is ideally suited to hydraulic equipment standardization and interchangeability, reducing replacement inventory. Our application engineers will supply detailed information without obligation. General Catalog 5001B is available upon request.

7996

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1474 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS TULSA • WORCESTER • Factories also in: AUSTRALIA, ENGLAND, JAPAN AND GERMANY • In Canada: Vickers-Sperry of Canada, Ltd., Toronto, Montreal and Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Why Use Less Than Chemlon* Packings In Your Hydraulic Cylinders

VISIT US AT THE DESIGN SHOW BOOTH 555

Hydraulic equipment manufacturers are now taking a *second* look at the many advantages of "John Crane" CHEMLON hydraulic packings and offering them in place of leather, fabric-reinforced and similar packings.

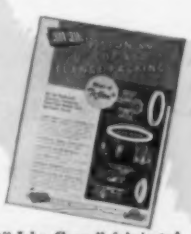
THE REASON . . . CHEMLON provides several very important service advantages.

1. Increased cylinder life due to the inherent non-frictional qualities of CHEMLON.
2. Longer packing service life—CHEMLON outlasts all other types of packing to a remarkable degree . . . decidedly cuts replacement, down time and maintenance.
3. Universal application—CHEMLON'S inertness to all types of hydraulic fluids, including non-flammables and synthetics . . . eliminates the need for customers stocking a wide range of special packings.
4. Trouble-free performance—CHEMLON withstands temperature conditions encountered in hydraulic service up to 350°F.

"John Crane" CHEMLON–*The Best in Teflon*–offers a complete line of piston cup, "U" cup and flange packing for every service requirement.

Get the new bulletin No. P-322 on "John Crane" Hydraulic Packings.

Crane Packing Co., 6405 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



*"John Crane" fabricated from DuPont Teflon

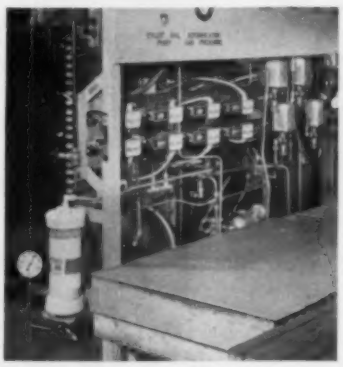
John Crane

MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

CRANE PACKING COMPANY

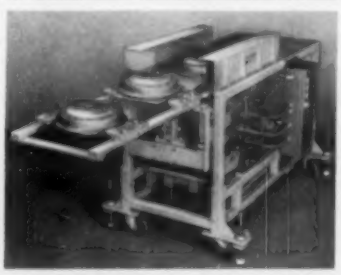
BRIEFS

stand. The accumulator has two purposes. First, it damps line surges in the independent, pilot-pressure system where the frequent and intermittent demand for



Courtesy Parker-Hannifin Corp.

oil would cause vibration of the tube lines. Second, the accumulator stores enough oil to shift the valves through a complete cycle of the test stand if the pilot pump fails. The piston type accumulator is part of a line of 14 models, ranging in capacity from 10 cubic inches through 10 gallons. ▼▼▼

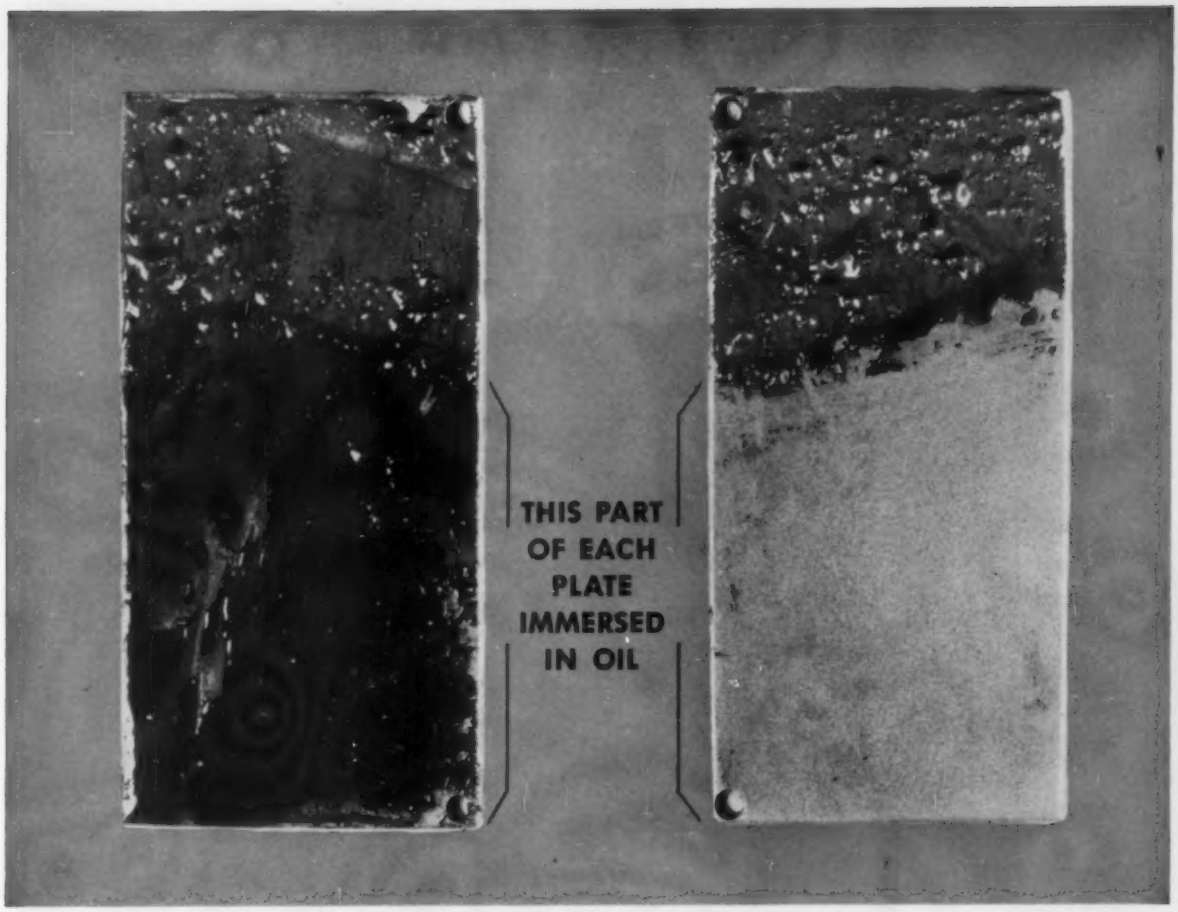


AIR-OPERATED, electrically-controlled air cylinders control the motions of the transfer bar in this combination feeder and unloader designed by Press Automation Systems, Inc., Centerline, Mich. One cylinder raises and lowers the bar assembly; another controls the forward and reserve motions.

Hydraulics Powers Swing Shift

Yale Materials Handling Div., The Yale & Towne Mfg. Co., has provided a swing shift, side shift attachment for its gasoline-power-

Continued on page 60



This sludge-coated metal plate was partially immersed in a beaker containing a *regular hydraulic oil* heated to normal operating temperature. Though the oil was agitated throughout the test, nearly all the sludge remained on the plate.

This similarly sludge-coated plate was partly immersed in a SUNVIS 700 oil, also heated to normal operating temperature. During the same period, with the same degree of oil agitation, the immersed part of the plate was rinsed clean of sludge.

Simple test shows how

SUNVIS 700 OILS CLEAN HYDRAULIC SYSTEMS...WITHOUT SHUTDOWNS

Sunvis* 700 oils clean while they work. Their cleansing action removes deposits in systems contaminated by dust, sludge, varnish, and other foreign materials.

SUNVIS 700 oils carry these contaminants in suspension for easy removal. This eliminates costly teardowns. Systems stay clean. In addition to being ideal for hydraulic systems, SUNVIS 700 oils are also suited for circulating systems and gear boxes.

If you want exceptional cleaning ability, oxidation stability, rust prevention, film strength, you need SUNVIS 700 oils. Ask your Sun representative for full details, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. AH-4.

INDUSTRIAL PRODUCTS DEPARTMENT

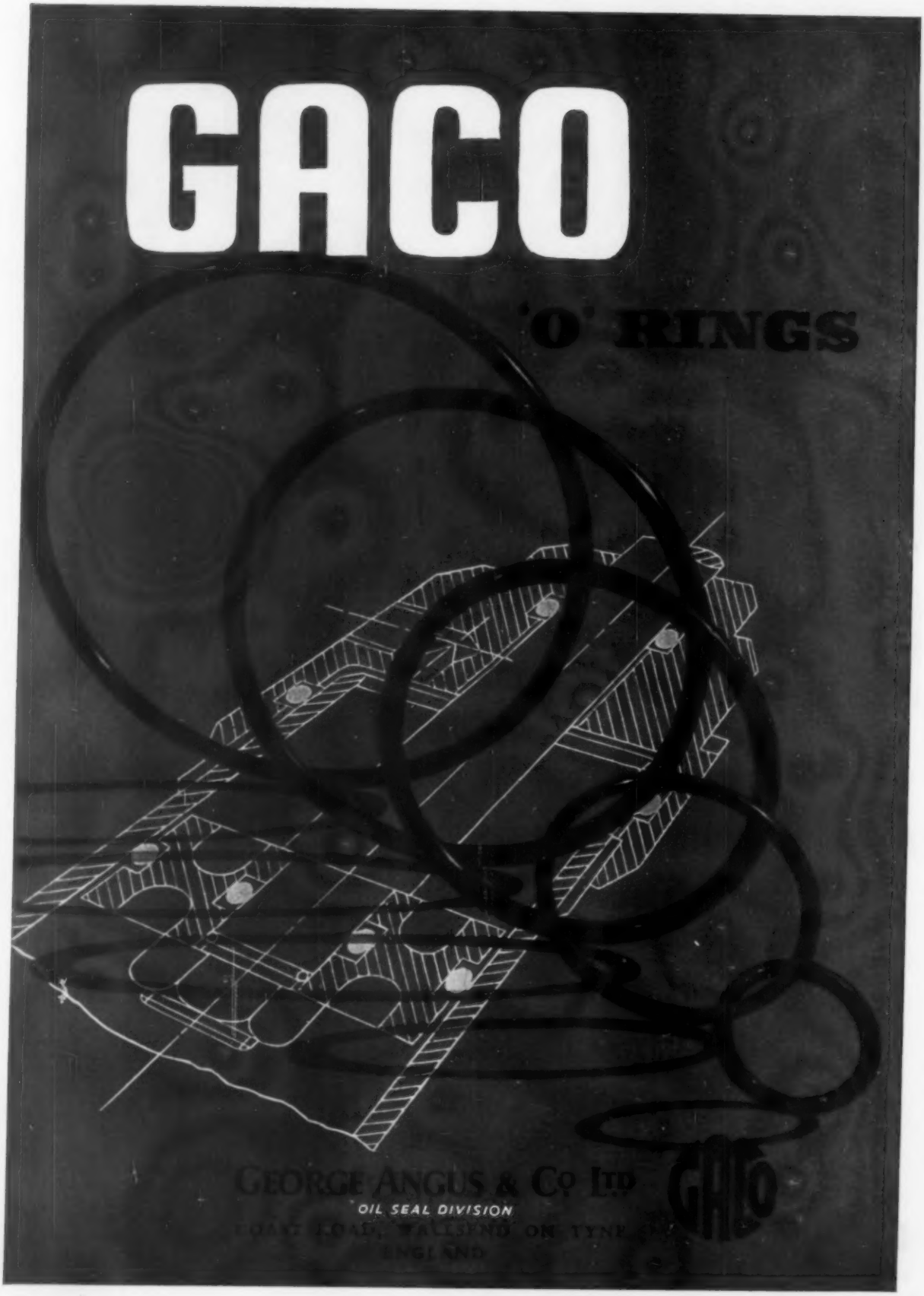
SUN OIL COMPANY Philadelphia 3, Pa.

IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

SUNOCO

*TRADEMARK

CIRCLE 131 ON READER SERVICE CARD


GACO
'O' RINGS
GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
ENGLAND

air circuitry:

a new term of importance to control engineers.

Air has come of age as a control medium. No longer is it confined to the simple jobs of pushing a clamping device, moving a lever, or blowing chips. No longer is an air circuit just a valve, reservoir, and cylinder. Today the most complex of industrial control problems can and are being solved efficiently with air.

Today, pneumatic circuits can be interconnected. They can be set to control a complex sequence of operations *automatically*. They can be combined with electrical circuits. There is *no* control problem you have that can't be solved successfully with air.

The new role that pneumatic control can play in industrial operations demands a new way of thinking about air control. It demands a new way to describe control by air—a new name that suggests some of its limitless control possibilities. That's why Westinghouse Air Brake Company is now using the term "air circuitry" to describe the application of air control to automation.

Westinghouse Air Circuitry, we realize, has to be more than *just as good* as your present means of control. It has to offer you *extra advantages*. And it does.

Chief among these is its extreme simplicity. The devices themselves are uncomplicated mechanical devices. They have few moving parts. They are easy to service by any mechanic. The circuit connections are made with pipe—and what could be simpler than that!

This extreme simplicity brings with it other important "pluses" for air circuitry. The simple equipment is unusually reliable—there are few moving parts to wear out or get out of adjustment. The devices are sturdy and durable. They require very little maintenance. What maintenance there is can be handled without the services of highly trained technicians.

Above all, remember: no means of control is as *safe* as air.

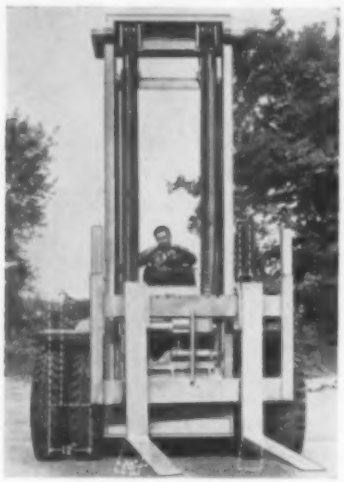
Air circuitry can help you simplify your control problems. It can help you get accurate answers to your automation problems on any industrial machine . . . in any industrial process. And Westinghouse Air Brake Company can help you with the engineering of a suitable system. Westinghouse has been in the control engineering business for 80 years now. It has been at the forefront of the development and improvement of air control equipment and its applications.

For more information on Westinghouse Air Circuitry—how it has helped other companies, how it can help you—write for your copy of "Basic Pneumatic Control," or call our nearest sales office.

WESTINGHOUSE AIR BRAKE COMPANY, INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PA.

BRIEFS

ed, 15,000 to 20,000-pound lift trucks. By allowing the fork carrige to be shifted 6 in. either side



of center, and rotated 10 degrees in either direction, it reduces the space needed to get the truck in position to pick up or deposit a load. Both actions are done hydraulically with separate cylinders controlled by conveniently placed handles. Either side- or swing-shifting can be done independently or in combination. ▼▼▼

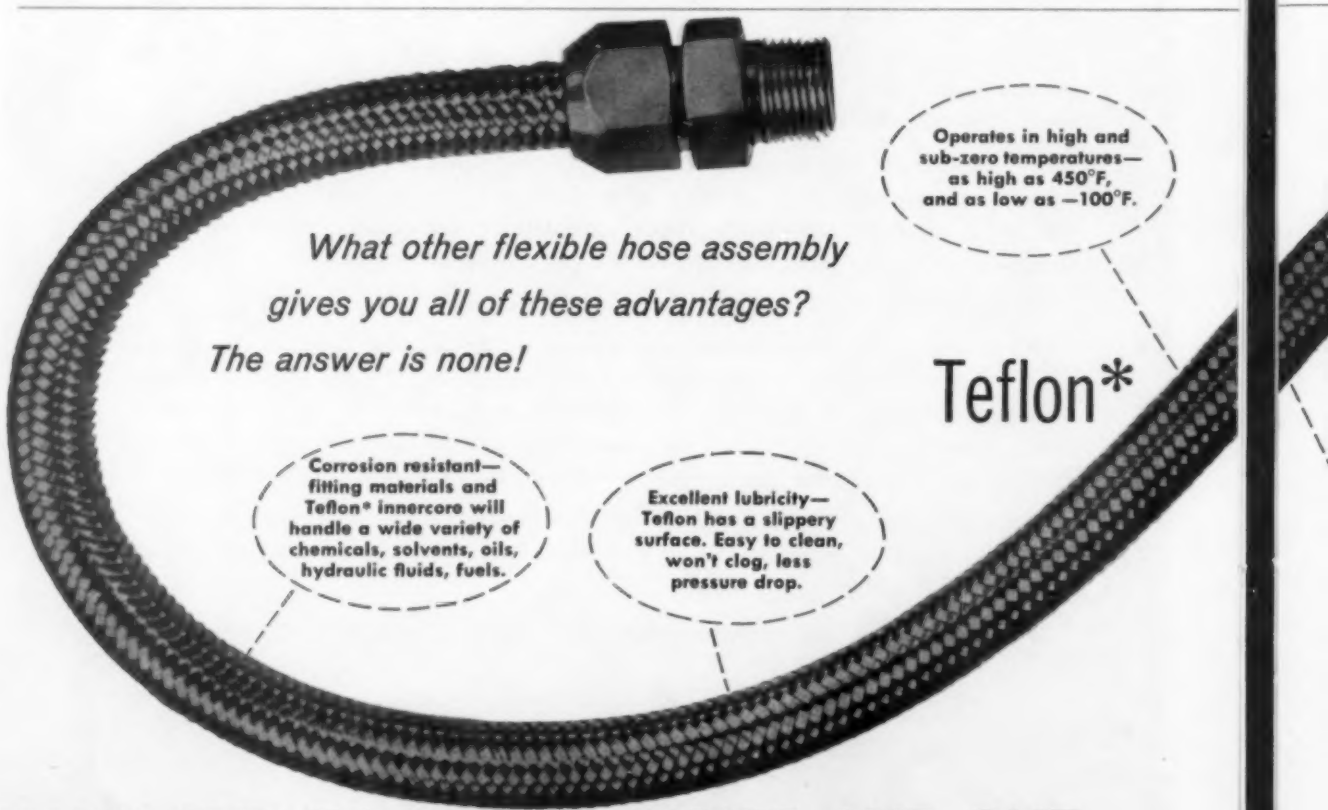
Recent Publications

Determination and Correlation of Flow Capacities of Pneumatic Components by D. H. Tsai and M. M. Slawsky, National Bureau of Standards Circular 588, 10 pp., price 10 cents.

Circular discusses an area factor for relating size, flow and pressure drops in pneumatic components. The dimensionless area factor is essentially the ratio of the flow factor of a component to the flow factor of the inlet port, or of some other convenient reference area.

Special reference is made to pneumatic components for aircraft application, but methods can, for the most part, be extended to other flow handling devices. Likewise, although discussion is limited to airflow, it may also be applied to other gases.—Order from: Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

AUTOMATIC PIPE-HANDLING and finishing machine takes vertically extruded pipe directly from the press to the spigot finishing line. All controls except the grips are hydraulically operated. The grips are air-pressure controled to avoid damaging the pipe. Designed by Pearne and Lacy Machine Co. Inc., Los Angeles, Calif.


What other flexible hose assembly
gives you all of these advantages?
The answer is none!
Teflon*
Operates in high and sub-zero temperatures—as high as 450°F, and as low as —100°F.
Corrosion resistant—fitting materials and Teflon* innercore will handle a wide variety of chemicals, solvents, oils, hydraulic fluids, fuels.
Excellent lubricity—Teflon has a slippery surface. Easy to clean, won't clog, less pressure drop.
FROM END TO END . . . INSIDE AND OUT

Flow Directory: Edited by Flow Magazine and Material Handling Illustrated. Published by The Industrial Publishing Corporation, 812 Huron Road, Cleveland 15, Ohio, price $7.50.

This 960-page directory is a complete guide to manufacturers and suppliers of material handling, packaging, and shipping equipment. The directory is divided into sections covering manufacturers, trade name index, local outlets, and engineering data.

Fluid Power Lifts 3200 Ton Water Tower

An interesting method of construction, involving the use of fluid power, has recently been used in Sweden for raising a 3200 ton water tower. The tank at the top of the tower has the shape of an inverted cone with a diameter of 145 feet at the top. The tank was built on the ground and raised to the top of a central supporting column, 100 feet high, by

Continued on page 62

BRIEF NOTES

REPORT ON FLOW CONTROL VALVES . . . a 102-page analysis of pressure-compensated, flow control valves has been completed by Dennis W. Prosser of the National Conference on Industrial Hydraulics Laboratory. It shows how analytical investigation can help in the design of valves.

BETTER NAMEPLATES . . . showing the JIC symbol to indicate valve operation. This helpful addition is being made by Denison Engineering Division on a line of valves being introduced this month.

NCIH APPOINTMENT . . . to serve on the industrial board, was made to Donald A. Stark, President of Fluid Controls Inc., Mentor, Ohio. Term is for 3 years.

A HYDRAULICS DIVISION . . . has been formed by the Brown and Sharpe Mfg. Co., Providence, R. I. The division combines three previously independent business activities: Brown and Sharpe's former Hydraulic Products Div.; The Double A Products Co., Manchester, Mich.; and the power unit portion of the Rosaen Co., Hazel Park, Mich.

TITANIUM PIPE FITTINGS . . . will be offered by Tube Turns a division of National Cylinder Gas Co. These will include welding fittings and flanges.

ANALOG COMPUTER . . . has been installed by the Pacific Division, Bendix Aviation Corporation, Hollywood, Calif., to solve engineering problems. Inputs may be applied to the simulated system and results observed directly. Computer will be used for analysis of hydraulic, electronic, and electromechanical systems.

Titeflex Springfield "140"

The Teflon innercore makes Springfield "140" hose assemblies extremely flexible. Long fatigue life.

Hose Assemblies with Reusable Fittings

Springfield "140" Teflon Hose Assemblies are approved for 1500 psi systems. Nominal hose diameter ¼" to ¾". Male pipe and J I C female swivel fittings available from stock.

In which of these applications can you use Titeflex Teflon?

- Acid handling
- Hot waxes and fats
- Liquid adhesives
- Silicone oils
- Chemical processing
- Food and beverage processing
- Steam lines
- Hydrogen peroxide
- Hot lacquers and enamels

Look in the yellow pages of your directory for the Titeflex distributor nearest you, or write direct for Titeflex Springfield "140" Catalog Supplement

Long life—Springfield "140" is unaffected by aging. Shelf life is practically unlimited.

*Teflon is a DuPont trademark for its tetrafluoroethylene resin.

TITEFLEX, INC., 601 HENDEE STREET, SPRINGFIELD, MASS.

. . . MADE RIGHT IN OUR OWN PLANT

FULFLO

piston-type
oil relief
by-pass valves
for O.E.M. or
replacement

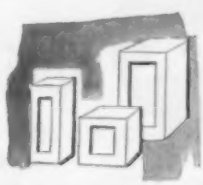
Best Buy because

QUICK DELIVERY

Fulflo stocking policy *and* practice permits quick shipment from stock of most standard types. Shipment is usually made *within 24 hours.*

TECHNICAL SERVICE

Fulflo engineers are ready *and* able to help you with any valve problem. Modified standard or special valves can be provided for any need.



WIDE RANGE OF TYPES AND SIZES

- Standard and flanged models
- Just 6 springs for pressures to 500#
- Wide range of brass, cast iron or steel bodies . . . brass, steel or stainless pistons
- Pipe sizes to 3"
- SPECIALS to your requirements

Write for "Fulflo Valves Mechanical Data Book"

FULFLO

THE FULFLO SPECIALTIES CO., INC.
415 FANCY AVENUE • BLANCHESTER, OHIO

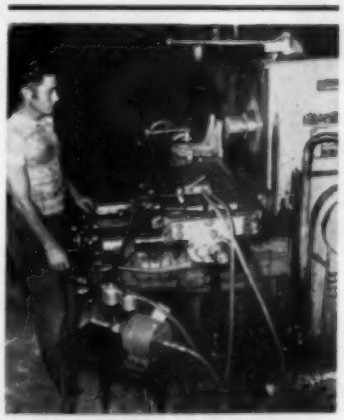
BRIEFS

means of 32 hydraulic cylinders. The tank was raised step-wise by the cylinders as the central sup-

porting column was built beneath. The tank rose 2 feet per day.

• **Lifted manually**—To insure perpendicular motion the actual lifting was done by hand. First 29 pump supplied cylinders were supplied with sufficient pressure to apply a lifting force of about 3000 tons. The remaining 200 tons was then supplied by three manually pumped hydraulic jacks. ▼▼▼

Continued on page 64



AUTOMATIC CLAMP can be moved easily from one machine to another. It's air-hydraulic made by Wilton Tool Mfg. Co. Inc., Schiller Park, Ill. It consists of a clamping head, air-hydraulic booster, filter-lubricater, control switch, and connecting tubing, all mounted on a small portable table.

RMC Instruments for Hydraulic Pressure Systems

Tell us your requirements for indicating instruments or actuating switches and let RMC engineering skill go to work for you.

ROCHESTER
MANUFACTURING CO., INC.
209 ROCKWOOD ST.
ROCHESTER 10, N. Y.

RMC
LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

HIGH PRESSURE GAUGES

The RMC-Lindsay gauge, designed for pressures from 1,000 to 15,000 PSI, is a multiple coil, helical Bourdon tube type. The pointer is attached direct to the tube, without linkages or pivots. This gauge is made for extensive cycling, and will meet rigid vibration and over-pressure requirements—can withstand extreme conditions of shock, vibration or temperature. These gauges are made in various models to meet specified pressure requirements for a wide range of applications, including guided missile and jet aircraft service.

MODEL #6903-7 (Actual Size)

MODEL #6901
(Actual Size)

PRESSURE GAUGES

MODEL #2650—RMC pressure gauges are capable of withstanding very high overload pressures above a nominal scale reading. Various types are available in different models, sizes, etc. All are built for use on heavy-duty equipment, to maintain accurate readings regardless of mechanical vibration, or exposure to dust and weather.

PRESSURE/VACUUM SWITCHES

MODEL #2900—The RMC 2900 series is designed for service on vibrating equipment. Mechanism is sealed dust-proof and watertight. The diaphragm is Buna N impregnated and calibrated at the factory to close or open a contact at fixed pressure (or vacuum) values. Double or single terminal models. Pressures from 4 to 100 PSI. Vacuums from 4 to 26 in. Hg.

THERMOMETERS

MODEL #1848—RMC's general line of industrial thermometers cover just about every possible application. All are of stainless steel construction, with hermetically sealed dials. They are factory calibrated and pressure tested. External dial reset device permits on-the-job calibration for pin-point accuracy.

CIRCLE 114 ON READER SERVICE CARD

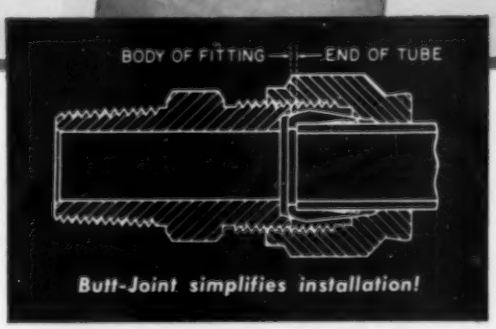
IMPERIAL HI-SEAL BUTT-JOINT FITTINGS

now available in brass, steel and stainless steel

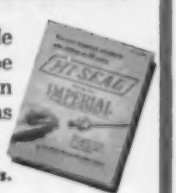
- No flaring or threading
- Withstands higher pressures
- No need to spring tubing
- Permits closer tube bends
- Fast, foolproof assembly
- Meets J.I.C. and A.S.M.E. standards . . . Listed by UL

Tremendous popularity of steel and stainless steel Hi-Seal fittings has led many users to request Hi-Seal fittings in brass. You wanted them—Imperial made them — new brass Hi-Seal fittings . . . plus steel and stainless steel fittings so you can profit from famous Hi-Seal advantages . . . like butt-joint, close bends, quick assembly in the metal best suited to each application.

Tube doesn't enter the body of the fitting. It bottoms on shoulder of the sleeve. Camming action of the nut causes sleeve to form a collet-type triple-seal grip on the tubing.



Final circumferential seal is made by tapered edge of sleeve. No tube torqueing when making a joint. Can be disconnected and reconnected as often as desired.



Write for Bulletin 3061 and complete facts.

See Your Imperial Distributor

IMPERIAL **THE IMPERIAL BRASS MFG. CO.**

6300 W. Howard St. • Chicago 31, Ill. • In Canada: 18 Hook Ave. • Toronto, Ont. • Dept. AH-48

IMPERIAL—offers industry's most complete line of fittings and tools for steel, stainless steel, copper, aluminum and plastic tubing.

FLARELESS TYPE FITTINGS

HI-SEAL
Brass
Steel
Stainless Steel

HI-DUTY
Brass
Aluminum

FLEX
Brass

POLY-FLO
Brass

NYLO-SEAL
Nylon

ERMETO
Steel

COMPRESSION
Brass

FLARED TYPE FITTINGS

37° FLARE
Brass
Steel
Stainless Steel

45° HEAVY DUTY FLARE
Brass

45° FLARE AND INVERTED FLARE
Brass

BRASS PIPE FITTINGS

PRESSURE HOSE AND REUSABLE COUPLINGS

Rubber Covered, Rayon Braid Hose — for low pressures.

Cotton Covered, Single Wire Braid Hose — for medium pressures.

Non-Skive Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Double Wire Braid Hose — for high pressures.

FLUID CONTROL AND SHUT-OFF VALVES

Needle Type
Toggle Type
Diaphragm Type
Plug Type
2, 3 and 4-way styles

TUBE WORKING TOOLS

CUTTERS
Tube Cutters
Sawing Vises

FLARING TOOLS
45° Flares
37° Flares
Double Flares

TUBE BENDERS
Lever Type
Gear Type
Spring Type

Reamers
Swaging Tools
Test Plugs and Caps
Refacing Tools

Emblem of Quality

BRIEFS

Rapid Return On Hydraulic Table

The DoALL Model 26-3 production band machine can now be equipped with a single cycle automatic table return. In operation a trip dog engages a limit switch when the table reaches the desired infeed point. A solenoid valve is then actuated to return the table to loading position. The table remains in loading position until the cycle start button is pressed. Feed rate and pressure

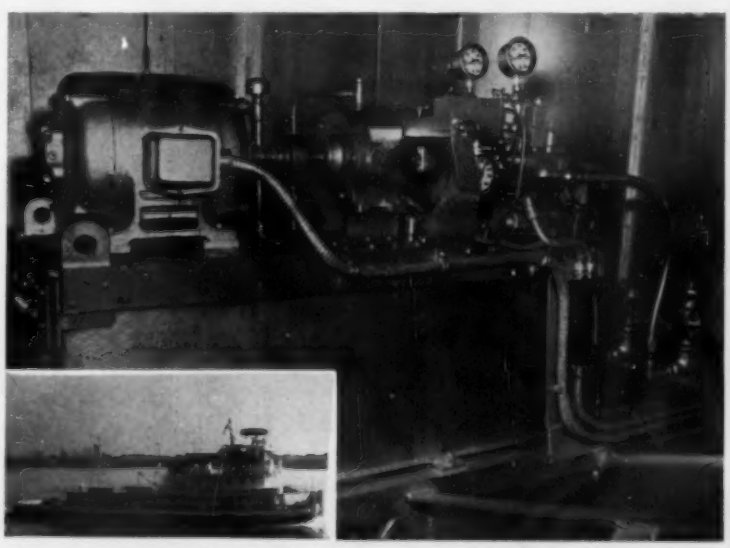
are established by the normal table hydraulic controls. Once these controls are set they need not be touched during a production run.

Hydraulic Power Steers River Towboat

Using electro-hydraulic power steering, the Cypress is probably the most maneuverable river towboat in service. Rudder movements are controlled through 80 degrees arc in 10 seconds. Even while going astern at nine miles per hour, the rudders can be brought from hard-over to midship position in normal time.

• **Hydraulic steering**—Flanking and main rudder electro-hydraulic systems are independent. Each system is powered by a 15 hp electric motor driving a pump supplying pressure to the hydraulic rams which are arranged in push-pull. Dial-type rudder angle indicators in the pilot house are connected to main and flanking rudders. Flanking rudders have individual controls and are not tied into the automatic steering system. When the craft is going astern, they are used to direct the propeller slipstream and improve maneuverability.

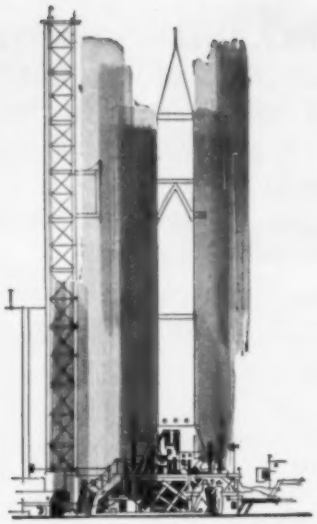
• **Pumps**—Sperry Gyroscope Co. designed 15 hp, variable delivery pumps, with new servo control valves, for this steering system. The variable delivery pump unit, which normally operates the flanking rudders, can also be used for auxiliary main rudder operation. Through the use of solenoid valves, the transfer can be made instantly from the pilot house.



Cypress is equipped with electro-hydraulic steering systems for improved maneuverability. 140 ft. motor vessel has a 30 ft. beam and draws 10 ft. 5 in. of water. Hydraulic steering is powered by variable delivery pump with 15 hp motor and servo controls.

Quality... from start to finish!

Versatile ACIPCO Centrifugally Spun Tubes



Look at that surface! Belt-polished to ±.0015", tolerance and 25 microinch finish, this 20′ long, 26.25″ OD, Type 4130 steel tube was produced at ACIPCO for use as a hydraulic cylinder plunger. This application graphically demonstrates the completeness of ACIPCO's extensive Machine Shop facilities.

ACIPCO can turn and finish up to 60″ diameters and 41′ lengths . . . hone up to 29″ ID's and 16′ lengths. Turning, honing and other related machining equipment occupy more than 100,000 square feet of modern Machine Shop construction.

ACIPCO tubes are available to you "Custom Spun" in lengths up to 16′. . . diameters up to 50″. . . and thicknesses up to 4″. Welded assemblies can be supplied in any transportable length. ACIPCO produces standard and special analyses in steel and cast iron, including heat and corrosion resistant stainless steels. Tubes can be furnished as-cast, rough machined or finish machined, including honing.

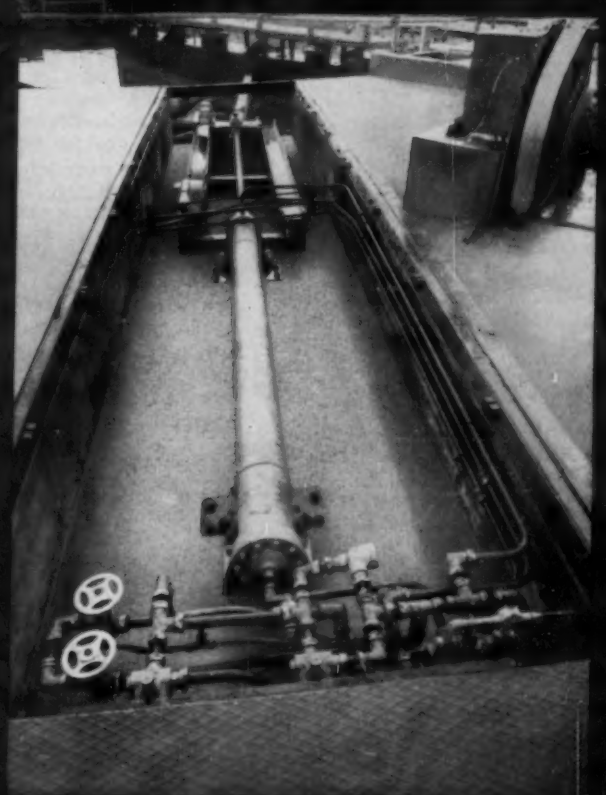
Investigate the plus advantages of Acipco's "one-source — from start to finish" service. Write for full information or technical assistance.

SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA

Keelavite HYDRAULICS



THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

USEFUL LITERATURE

For your free copy of publications reviewed, fill in the reader service card

PRESSURE GAGES . . . for hydraulic pressures to 30,000 psi are listed in catalog No. 76-G from *Jas. P. Marsh Corp., Skokie, Ill.* The gages are available in 3½ and 4½-in. dial sizes and eight case patterns. Catalog also describes internal construction and features of all Marsh gages and includes a section covering steel and stainless steel, 10,000-psi needle valves.

CIRCLE 400 ON PAGE 97

CONTROL VALVES . . . for air, water and oil are described in a bulletin prepared by *Westinghouse Air Brake Co., Wilmerding, Pa.* Valves are designated as type D Pilotair, and feature a seal which swells slightly in oil to compensate for wear. The spool type valves are available in 2, 3, and 4-way types and can be actuated by pushbutton, lever, solenoid, cam, pilot, or foot pedal. They are rated at 250 psi for air and 500 psi for water or oil.

CIRCLE 401 ON PAGE 97

O-RING . . . technical data log No. 1581 prepared by *Plastic and Rubber Products Co. Los Angeles, Calif.* is a 16-page booklet designed to help select O-rings. Specifications are given for both hydraulic and pneumatic equipment. The guide lists the relationship between military standards and industrial equivalents. A series of drawings shows typical O-ring applications.

CIRCLE 402 ON PAGE 97

MANIFOLDS AND SUB-PLATES . . . are detailed in a catalog issued by *Birmingham Hydraulic Products, Detroit, Mich.* It gives complete dimensional information on the company's standard line of side-entering and back-entering sub-plates, available for most standard, panel-mounted valves. The catalog also describes hydraulic drilled manifolds which are made according to customer's mounting requirements.

CIRCLE 403 ON PAGE 97

SERVO GUIDE . . . prepared by *Askania Regulator Co., Chicago, Ill.* describes their complete line of pneumatic-hydraulic position servos. The servos are a combination of position-sensitive air transducer and hydraulic, jet pipe regulator. This provides a high power output from extremely low level input signals. Bulletin No. 39.2.

CIRCLE 404 ON PAGE 97

TUBE FORMING FACILITIES . . . which include a 500-ton hydraulic press are described in a brochure released by *Aeroquip Corp. Jackson, Mich.* The booklet covers a typical case history where urgent requirement for a special

tube assembly was filled. The high pressure, press bender forms tubular elbows without thinning outer wall thickness. A section of the brochure gives important engineering data and design hints for engineers.

CIRCLE 405 ON PAGE 97

CYLINDERS . . . to JIC and automotive standards are described and illustrated in bulletin SS-58 issued by *Hydro-Line Mfg. Co., Rockford, Ill.* It gives the dimensions for the eleven models that comprise the S-2 series and includes all the data needed for mounting. Nine standard bore sizes are available from 1½ to 8 in. Pressure ratings are 200-psi air and 1000-psi hydraulic.

CIRCLE 406 ON PAGE 97

HYDRAULIC POWER PACK . . . for pressures to 6000 psi is described in a bulletin prepared by *Lincoln Supply Co., Pawtucket, R. I.* It contains charts listing pressure output, gpm, and hp input. The units can be furnished with either gear or vane pumps. The bulletin also describes the engineering service to design and install complete hydraulic systems.

CIRCLE 407 ON PAGE 97

HIGH PRESSURE FILTER . . . that will stand 3000 psi across the element is described in bulletin PFD-1157-5 prepared by *Poroloy Equipment, Inc., Van Nuys, Calif.* Elements are available to filter from 5 to 250 microns. They come in ¾ and 1-in. sizes and are rated at 12 and 24-gpm of oil. Housings can be aluminum or stainless steel.

CIRCLE 408 ON PAGE 97

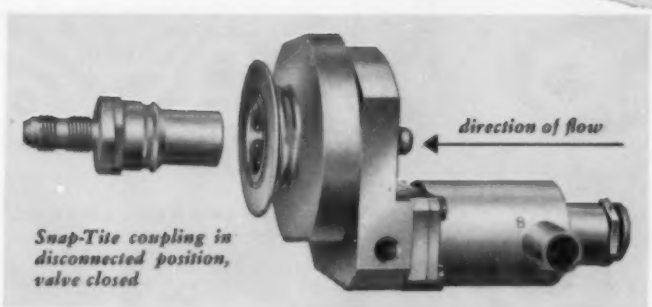
PACKING HANDBOOK . . . which details a wide variety of packings, gaskets and seals is published by the *Garlock Packing Co., Palmyra, N. Y.* Designated Bulletin AD-162, it contains a detailed table listing the effect of many gases, liquids and solvents on packing materials. The bulletin has three sections covering static sealing, dynamic sealing, and recent information on Teflon.

CIRCLE 409 ON PAGE 97

For more reviews of FREE LITERATURE turn to page 156

CIRCLE 125 →

SNAP-TITE REMOTE CONTROL COUPLINGS FOR GUIDED MISSILES



Snap-Tite coupling in disconnected position, valve closed

Here is a specially designed Snap-Tite quick-connect, quick-disconnect coupling, ideal for use in missile-fueling systems. This unit is specifically designed to be manual-connected . . . can also be disconnected manually, or by use of an air-actuated remote control.

NOT A DROP SPILLED!

When the coupling is disconnected, it spills only that small amount of fluid which clings to the metal. The valves in both the coupler and nipple automatically shut off when disconnected, *with no leakage.*

NO AIR INCLUSION!

Coupling operation encloses only a minute amount of air.

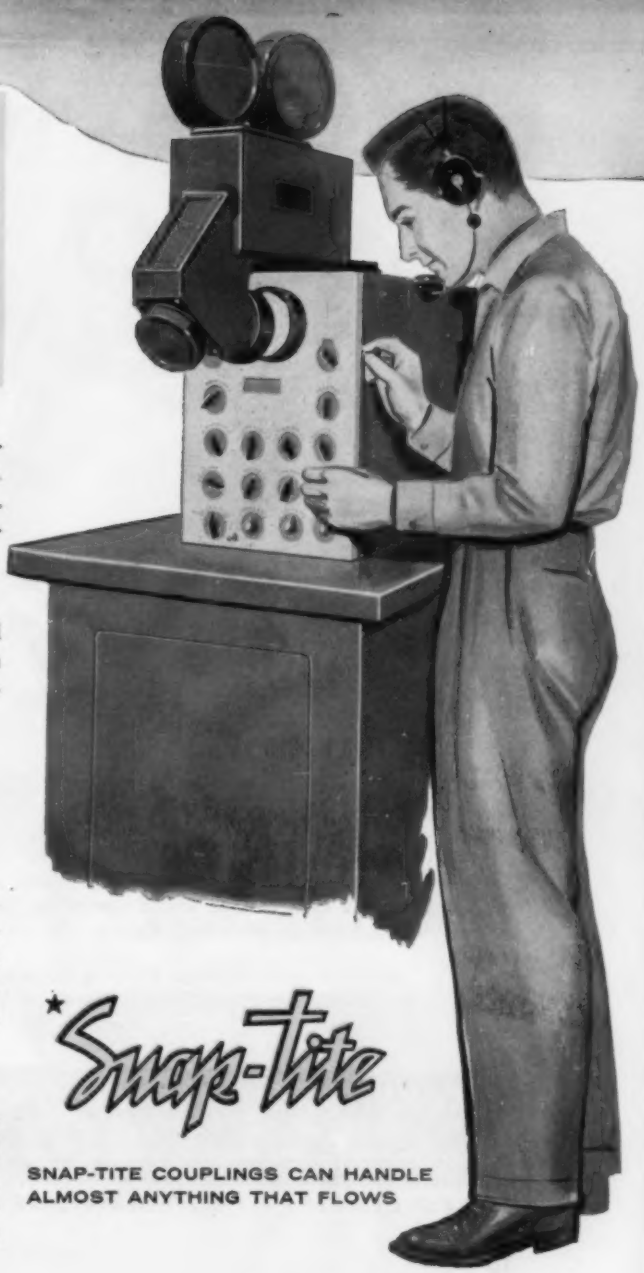
MINIMUM PRESSURE DROP!

Smooth, streamlined passages assure maximum flow.

Variations of this coupling, to meet your required specifications, can be furnished with the appropriate seals to handle liquified gasses, exotic fuels, and a large variety of fluids with working pressures up to 3,000 PSI and temperatures from −300°F to +400°F. Units have been designed up to and including 5″ size.

STANDARD COUPLINGS, TOO!

Your coupling needs might not be as critical as the coupling shown here, but you can be sure, when buying standard Snap-Tite couplings, that the same outstanding engineering and manufacturing skills are basic throughout the Snap-Tite line. Write for complete catalog . . . or describe your specific coupling problems. Snap-Tite, Inc., Union City 1, Pa.



★Snap-Tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

NEW Nickel-Plated Brass *Fulflo Filter* for Compressed Air

This new compressed air Fulflo Filter (B-R) is made of gleaming nickel-plated brass . . . sanitary and non-rusting. 7-inch Honeycomb Filter Tubes minimize gumming — remove moisture, oil, microscopic dust, rust, dirt, and scale. Flow rate is as high as 76 cfm of free air at operating pressure of 100 psi. ⅜ or ¾ inch N.P.T.

For a new catalog on Fulflo Filters for compressed air, CO_2 and other gases, write to Department AH.

Single Tube Fulflo Filters

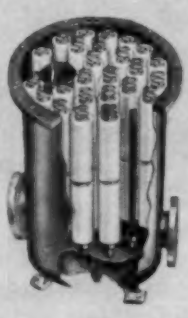
B-A model has 3, 5 or 7-inch Honeycomb Filter Tubes for 10, 30 and 60 cfm at operating pressures up to 125 psi. AF model has flow rate of 60 cfm at operating pressures up to 250 psi. ¾ inch NPT.

Hi-Pressure Fulflo Filter

Tested at hydrostatic pressure of 8,000 psi, this filter withstands operating pressure up to 4,000 psi. 7-inch Honeycomb Filter Tubes for 1.5 cfm at 4,000 psi (equivalent of 410 cfm of free air).

Multi-Tube Fulflo Filter

For high flow rates or central installations. Three, six, twelve, or eighteen Honeycomb Filter Tubes in parallel. Steel-and-iron, stainless steel, or nickel-plated brass containers. For 1½ and 2-inch pipes. Operating pressure up to 100 psi.



Hi-Capacity Fulflo Filters

This rugged filter is made in 10 sizes — from 22 to 270 10-inch Honeycomb Filter Tubes in parallel. Sturdy welded steel construction — 304 or 316 stainless steel to order. For 3, 4, and 6-inch pipes. 100 psi operating pressure.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

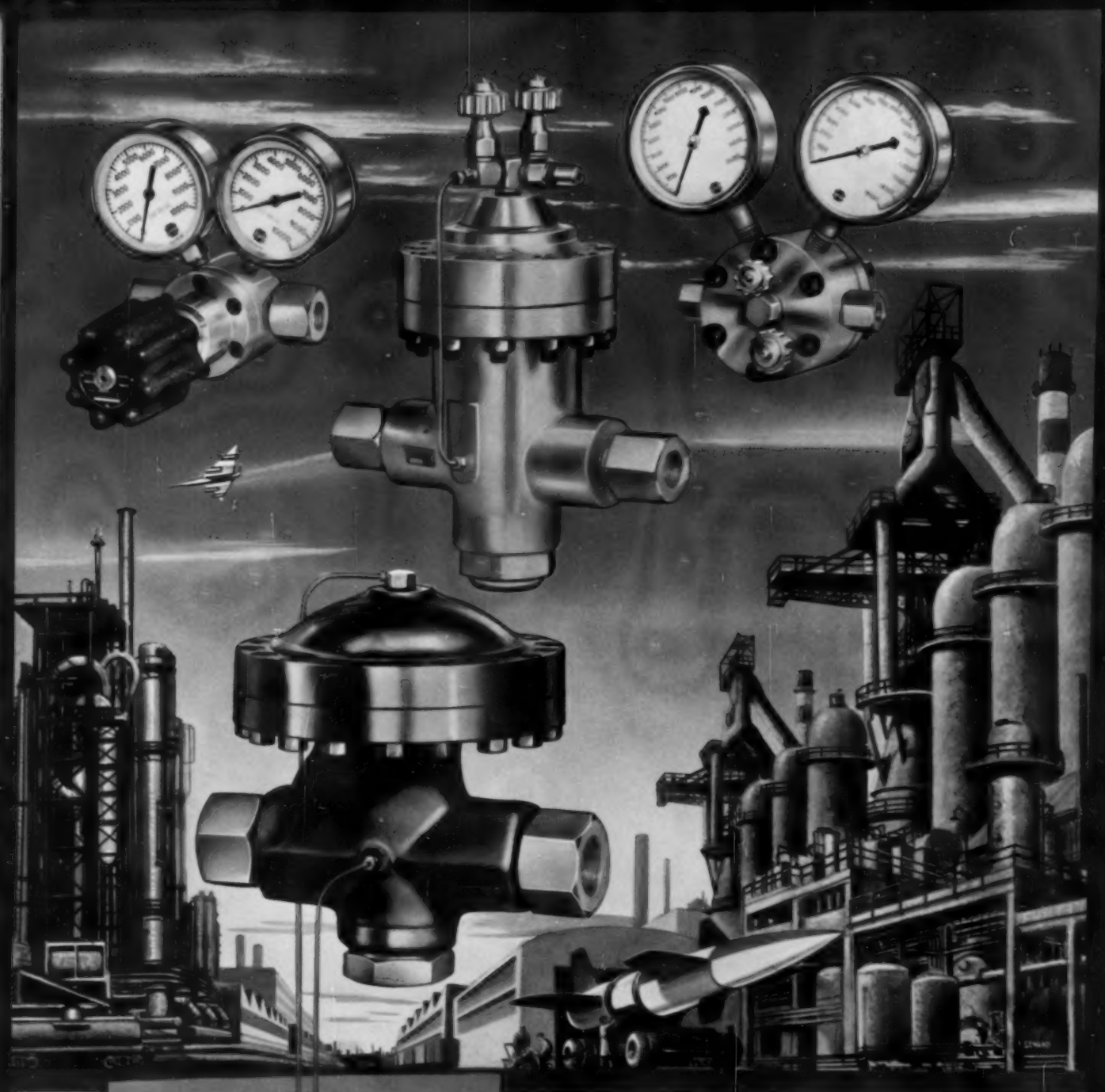
MICRO-CLARITY AT MINIMUM COST

Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*

CIRCLE 33 ON READER SERVICE CARD

CIRCLE 142 →



For accurate control of high pressure and large volume gas applications

VICTOR

VICTOR EQUIPMENT COMPANY

Mfrs. of welding & cutting equipment; hardfacing rods, blasting nozzles; cobalt & tungsten castings; straightline and shape cutting machines.

844 Folsom St., San Francisco 7 • 3821 Santa Fe Ave., Los Angeles 58

Get *SuperMarket* hydraulic service at your DENISON branch office

1. BRING US YOUR PROBLEM...

whatever hydraulic problem has you stumped. A trained Denison Hydraulic Specialist is ready to sit down with you and analyze your problem.

2. WE'LL DEVELOP YOUR CIRCUIT...

the most efficient hydraulic circuit to handle your specific needs. We can do this while you wait.

3. PICK OUT WHAT YOU NEED...

right off the shelf — from Denison's complete stock of hydraulic pumps, motors, valves and controls to 5000 psi.

4. TAKE HOME YOUR COMPLETE HYDRAULIC SYSTEM...

ready to go to work for you! Complete hydraulic circuit drawings and hydraulic parts are "under your arm" in a *complete package*.

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS MOTORS • CONTROLS

CALL ANY OF THESE DENISON STOCKING BRANCHES:

DENISON ENGINEERING DIVISION
American Brake Shoe Co.

- **LOS ANGELES** 565 North Prairie Ave. Hawthorne, California
- **DETROIT** 912 South Woodward Avenue Birmingham, Michigan
- **HOUSTON** 2501 Bartlett Street Houston 6, Texas
- **CLEVELAND** 5530 State Road Cleveland 34, Ohio
- **CHICAGO** 7000 West 63rd St. Chicago 38, Illinois
- **ATLANTA** 309 East Paces Ferry Rd., N.E. Atlanta 6, Georgia
- **NEWARK** 315 Central Avenue Clark, New Jersey
- **COLUMBUS** 1160 Dublin Road Columbus 16, Ohio

CIRCLE 38 ON READER SERVICE CARD

Republic ELECTRUNITE Hydraulic Line Tubing in ⅜″ to 1¼″ size is used throughout the automation operations of the Dearborn Engine Plant of the Ford Motor Company, River Rouge, Michigan. Pressures are 500 to 700 psi. And it has been reported that maintenance is practically no problem.

Republic ELECTRUNITE Hydraulic Line Tubing DEPENDABILITY...

transmits power for actuating machine and automation functions at FORD MOTOR COMPANY

Dependability that minimizes down time and maintenance costs in high pressure applications is the reason engineers at the Ford Motor Company include resistance welded tubing, such as Republic ELECTRUNITE®, as acceptable in their specifications.

At the Dearborn Engine Plant, castings, such as cylinder heads, travel down the production line, are automatically clamped in position in fixtures and come off finish-machined. These automated operations move in and out on hydraulic power, hydraulic power that depends on Republic ELECTRUNITE Hydraulic Line Tubing for power feed. The equipment manufacturer elected to furnish welded tubing in accordance with the Ford Motor Company specifications.

Republic dependability starts at the mine with the ore, is followed through to the finished product. Because the tube is formed from flat rolled steel, both inside and outside surfaces can be checked for defects. The resulting uniform wall of the tube, coupled with high ductility, provides excellent flaring and bending characteristics. And the tube is not subject to longitudinal and transverse cracks.

Republic ELECTRUNITE Hydraulic Line Tubing is available in a wide range of sizes and in wall thicknesses regularly used in hydraulic applications. And ELECTRUNITE Hydraulic Line Tubing is made only by Republic—world's leading specialty tubing manufacturer.

It will pay you to get all the facts and discover how you can substantially reduce maintenance costs and down time in complicated installations. Send coupon today for additional information.

REPUBLIC STEEL
STEEL AND TUBES DIVISION

REPUBLIC STEEL

Cleveland 8, Ohio

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
DEPT. C-4754
211 EAST 131ST STREET • CLEVELAND 8, OHIO

Please send me additional Republic ELECTRUNITE Hydraulic Line Tubing information.

Name_____ Title_____

Company_____

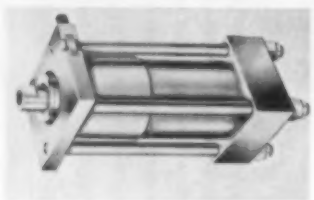
Address_____

City_____ Zone____ State_____

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For information on any item, fill in and mail post card bound in this issue.

HYDRAULIC CYLINDER . . . has locking device



Features: This cylinder rated at 2000-psi shock and 3000-psi non-shock working pressure has been tested at 10,000 psi without external leakage. It was designed for spar mill workholders to NAS-929 standards.

When equipped with these cylinders spar mills can machine material up to 24 in- wide and 60 ft. long. Each cylinder can be moved across the work-holder base and locked in place by a device built into the cylinder flange.

Hanna Engineering Works
Chicago, Ill.

CIRCLE 300 ON READER SERVICE CARD

HYDRAULIC PISTON PUMP . . . with built-in 4-way valve

Designation: Models 400 and 444
Features: Volumetric efficiencies of 85 to 90% at 2500 psi are possible with this piston pump. It has a built in 4-way control valve and relief valve which saves piping. Main crankshaft is supported with needle bearings, and pump may be rotated in either direction.
Specifications: Model 400 is a 2-cylinder pump delivering .45 cu. in./revolution and has a working pressure of 2500 psi. Model 444 is a 4-cylinder pump delivering 0.9 cu. in. per revolution and has a working pressure of 3500 psi.

Williams Machine Tool Co.
Omaha, Nebraska

CIRCLE 301 ON READER SERVICE CARD

PILOT-CHECK VALVE . . . provides emergency manual release

Features: Pilot check valve, normally used with hydraulic cylinders lifting or clamping, locks the cylinder in position preventing pressure loss due to leakage.

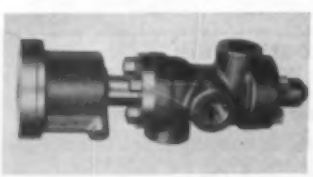
The manual pressure release safely releases the holding pressure on the clamp of lift cylinder in an emergency such as power failure.

Specifications: The pilot check valves are available in single and double models for pressures to 3000 psi. Port openings are ¼, ⅜, and ½-in. NPT.

Fluid Controls Inc.
Mentor, O.

CIRCLE 302 ON READER SERVICE CARD

CYLINDER-OPERATED VALVES . . . have high speed response



Features: This line of cylinder-operated hydraulic control valves was designed for high-speed response, and compactness. An integral, double acting cylinder reduces mounting space and gives rapid response.

Air, water, or oil may be used for operation. Valves are available in 2 or 3-way types and have bronze bodies and stainless steel internal trim.

Specifications: Valves have working pressures to 3000 psi and are available in 1, 1½ and 2 in. sizes.

Sinclair-Collins Valve Co.
Akron, Ohio

CIRCLE 303 ON READER SERVICE CARD

For more NEW PRODUCT reviews turn to page 140

MARVEL Synclinal FILTERS

Answer DESIGNERS' S. O. S.

For Dependable Protection on all Hydraulic and other Low Pressure Systems

Simple, Balanced Design . . . is the answer to the growing preference for MARVEL Synclinal FILTERS. Designers are specifying Marvel Synclinal Filters to assure minimum maintenance and maximum protection. Results show Marvel Synclinal Filters superiority in maintaining the greatest degree of cleanliness of liquids in all hydraulic and low pressure systems with minimum downtime. Furthermore, when filter servicing is necessary, Marvels can be easily disassembled, cleaned and reassembled by any workman in a matter of minutes. Line types operate in any position and may be serviced without disturbing pipe connections.

Again and again, Marvel Synclinal Filters have demonstrated they meet all requirements of the most exacting users, that today—OVER 800 ORIGINAL EQUIPMENT MANUFACTURERS install Marvel Synclinal Filters as standard equipment!

MEET J. I. C. STANDARDS

VISIT OUR EXHIBIT
Booth #956
1958 DESIGN ENGINEERING SHOW
International Amphitheatre
Chicago, Illinois
APRIL 14-15-16-17

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 20 to fine 200.

EASY TO CLEAN

Both sump and line types are easily disassembled, thoroughly cleaned and reassembled, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

IMMEDIATE DELIVERY

Catalogs contain dimensional charts and complete engineering data making it easy to order a filter for your specific requirements and get Immediate Delivery.

Catalogs containing complete data available on request.

Write or Mail Coupon.

MARVEL ENGINEERING COMPANY
7227 N. HAMLIN AVE.,
CHICAGO 45, ILLINOIS
Phone: JUNIPER 8-6023

Without obligation, please send me complete data on Marvel Filters, as indicated: (AH-4)

- ☐ Catalog #108—For Hydraulic Oils, Coolants, Lubricants
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

Name _____ Title _____
Company _____
Address _____
City _____ State _____

Factory fill is Texaco Regal Oil R&O both as spindle lubricant and as hydraulic power medium.

HOW TO DRILL A CAST IRON HARP IN ONE SHOT

This machine drills 417 holes (from 5/32" to 7/16") all in a single bite, the action being controlled by a powerful hydraulic system.

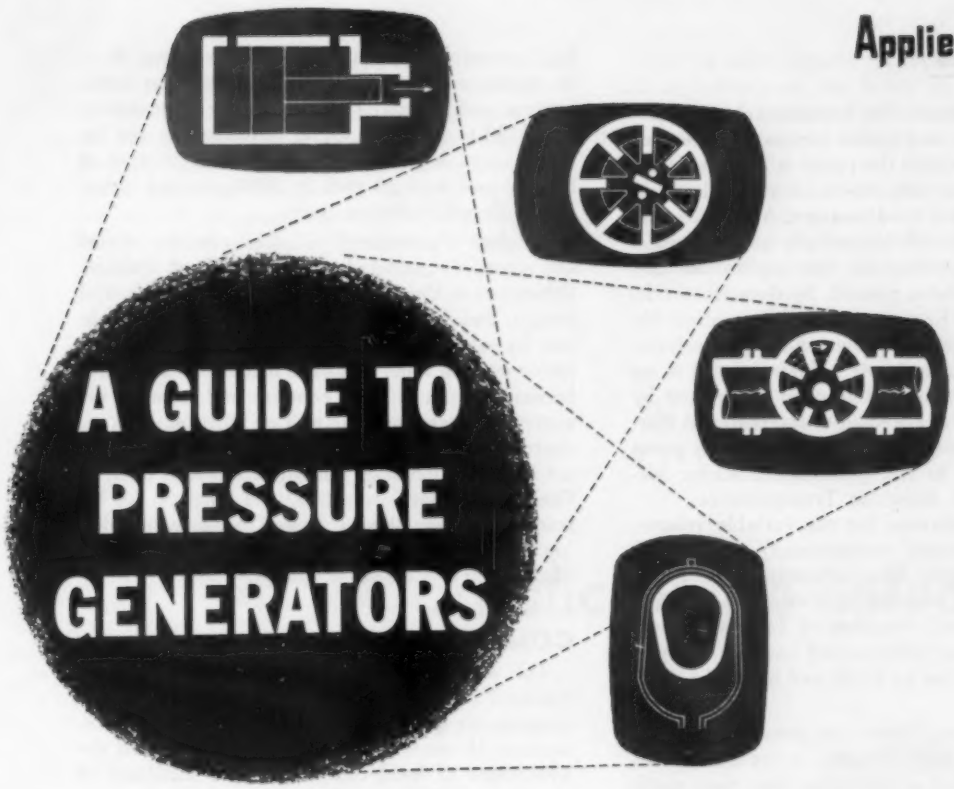
To keep the intricate valve and line system clean, to lubricate the spindles and assure their accurate functioning, the manufacturer specifies use of Texaco Regal Oil R & O. It has much greater oxidation resistance than regular machine oils. It prevents rust and foam. It keeps the machine's action smooth and effective. And, from the economy standpoint, it has a far longer service life.

Whatever your hydraulic equipment—from giant press to delicate control—there is a Texaco Regal Oil R & O exactly suited for the job. Call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

CIRCLE 132 ON READER SERVICE CARD



Power sources for fluid power systems

HYDRAULIC and pneumatic systems which convert and transmit power can be divided into three parts. The primary power source is a pump, compressor, or air-oil booster. Final output elements are cylinders, air or hydraulic motors, rotary actuators, or pressurized test elements. Valves are the intermediate controls which regulate flow (speed), pressure (force) and fluid direction.

In this issue, APPLIED HYDRAULICS turns its attention to the power sources: pumps, compressors, boosters, and also accumulators which are often used as auxiliary or emergency power sources. Selection of components depends very much on how they are used. The engineer designing farm tractors has far different yardsticks from the designer of missiles. Yet both use the same principles of hydraulics and pneumatics.

To get first-hand information how fluid power sources are being used—how they are selected and what the preferences and requirements are, APPLIED HYDRAULICS asked 2000 designers of machine tools, production tooling, presses, aircraft, mobile equipment and other equipment using air and oil power. Here is what they said . . .

PUMPS

Pressure is a primary factor in selecting a pump. Some gear pumps are rated to 2000 psi, but they are usually used at less than 1000 psi. Vane pumps are rated for 2000 psi in some designs, although 1000 psi is the maximum pressure for many types, Piston pumps—either axial or radial—usually do the higher pressure jobs.

POWER SOURCES

• **Variable Volume**—For variable volume applications, both vane and piston pumps are often selected, especially where the pump is pressure compensated to deliver only the amount of fluid required to maintain a fixed pressure. At MacGregor-Comarain, v-p Marc Zeitlin usually picks a radial piston pump depending on the application and suitability of available control. So does Robert R. Smith, Equipment Engineer at Bendix Aviation. He likes the low output pulsation and high performance. Constant and accurate volume control is an advantage of the radial piston pump pointed out by Ralph Eber, General Foreman at International Harvester. Finer volume control with this type pump is also important to Harry Gahagan, Master Mechanic of General American Transportation.

Stating his preference for the variable volume, vane pump (pressure compensated) Russell W. Henke of Russ Henke Associates emphasized its resistance to foreign material. The axial piston pump, said J. V. Bertrand, President of Improved Products Co. is the most efficient and compact. He prefers it because it has no pintle and no radial clearance problems.

• **Hi-Lo Systems**—Where low pressure, high volume followed by high pressure, low volume is required for tool feed or clamping, four main methods are used. These are hi-lo circuit using individual pumps and valves, hi-lo circuit in one housing (combination pump), reciprocating booster, and pressure compensated pump. All of these are being used with good results. E. Dunn of Gardner Machine Co. selects the combination pump because of the isolation of the pressure systems and of any shocks or pressure drops. Another advantage of this unit pointed out by Plant Engineer, H. J. Dewitt of Michigan Plating & Stamping is the small number of components and consequently easier maintenance.

Where two separate pumps are used in a hi-lo circuit, failure of one pump leaves the second pump for operation during repairs. While this may not work in some applications, it is an advantage in the paper machinery designed by Charles E. Hill, Chief Engineer of Patton Manufacturing Company.

• **What's Needed?**—The pumps now on the market are generally filling industry's requirements. For special cases of higher pressures at higher temperatures, of course, developments are going on. In mobile equipment, Vice President Robert L. Morse of Truck Engineering wants a gear pump with integral control and bypass valve rated at 30 gpm at 2000 psi and 750 rpm. Larger valume vane and axial piston pumps are needed for baling presses manufactured by Galland-Henning Mfg. Co., William Hunter, Chief Engineer of the Baling Press Division said.

For portable equipment, H. M. Stein, Tool Design Engineer of Anderson-Electric needs a small, high pressure, medium volume pump driven by a d-c motor not to exceed 2 lb. His machine tools, presses, and industrial trucks operate at pressures from 150 to 3700 psi. Other requirements are for a combination pump delivering about 35 gpm at 500 psi and 6 to 10 gpm at 2500 psi, and a low price, 50-gpm, 6000-psi pump.

• **Higher Pressures?**—Higher pressure scares off some designers who fear increased leakage. Others want the advantages of smaller size and weight, and feel they can solve the leakage problem by newer piping methods. Compactness is a factor even on some industrial machines which have become more and more complex and must be designed for appearance as well as function. Leakage control is especially important to protect the product in rubber molding, but Otto Hermanns of B. F. Goodrich is considering 6000 and 8000 psi for his transfer molding presses. Russell Henke is considering 3000 to 5000 psi for mobile equipment instead of the 1000 to 1500 psi now used.

COMPRESSORS

The central compressor installation is almost standard in industry, with the number and size of compressors depending entirely on the type of production. However, some plant engineers noted the advantages of local compressors for auxiliary or standby use. Clarence White, Consulting Engineer of Youngstown Kitchens Division, American Radiator, said, "The individual compressor is good where higher than standard pressures are needed, for isolated locations, or if a small amount of air is required by only a few machines in the plant." Much of the reason for central system dominance is lower first cost. "The central system reduces maintenance spares and thus lowers overall maintenance cost. Loads are more easily matched to a central system compared to individual compressors for machine. Process changes can upset load requirements in individual compressors." This was the comment of Floyd Wondisford, Chief Engineer of Younstown Manufacturing.

Indicating the auxiliary uses of individual compressors, James Janson, Vice President-Engineering of Associated Co. said his plant has one 50-hp, 40-hp, 10-hp, and one 5-hp compressor. The two large ones serve most of the plant. The smaller ones are located where the air is required 24-hours a day. This saves supplying air to the whole plant full-time.

ACCUMULATORS

Designers who participated in the APPLIED HYDRAULICS survey indicated they are using accumulators in almost every type of machine. Centerless and internal grinders, lift trucks, rubber calendars and presses, gear generators, and welders are some of the applications. One unusual application is to maintain pilot pressure on paper cutters designed

by T. D. Barely, Project Engineer of Harris-Seybold. The spring-loaded accumulators are manufactured by his company. Everett Berrg, Supervisor of Machine Maintenance at Johnson Motors Division, Outboard Marine Corp., says he is using accumulators to pressurize cylinders during an index operation where the pressure source is blocked temporarily. He is also using nitrogen-charged tanks for faster cylinder speeds on die casting machines.

Bladder and piston type accumulators seem to be preferred about equally in industrial applications. Aircraft designers are faced, as always, with the problems of space and weight. Dick LaBelle who designs missile hydraulics and associated test equipment at Bendix Products Div.-Missiles said that whether he uses a bladder, piston, or nonseparator type accumulator depends on the space in which it must fit, the position in which it will operate, and whether absolute separation between gas and fluid is required. ▼▼▼

Hydraulic pump selection

When should you use a gear pump, a vane pump, a piston pump? Here are some answers for industrial and mobile applications.

HYDRAULIC pumps differ in details but have one thing in common. They are all positive-displacement pumps. This means that for each revolution of the pump shaft, a nearly fixed quantity of liquid is delivered, regardless of changes in the pressure against which the pump is working.

PERFORMANCE MEASUREMENT

Volume of fluid pumped per revolution is calculated from the geometry of the oil carrying chambers. A pump never quite delivers the calculated amount of fluid. How close it comes is called volumetric efficiency, and it is found by comparing the computed delivery with actual delivery. Volumetric efficiency varies with speed, pressure and the construction of the pump.

A pump's mechanical efficiency is less than perfect, because some of the input is wasted in friction. Overall efficiency of a hydraulic pump is the product of its volumetric efficiency and the mechanical efficiency.

TYPES AND PERFORMANCE

• **Gear Pumps**—Gear pumps can be divided into external and internal gear types. Typical external gear pumps are shown in Figure 1. They may use straight spur, helical or herringbone gears. Straight spur gears are easiest to cut and are the most widely used. Helical and herringbone gears

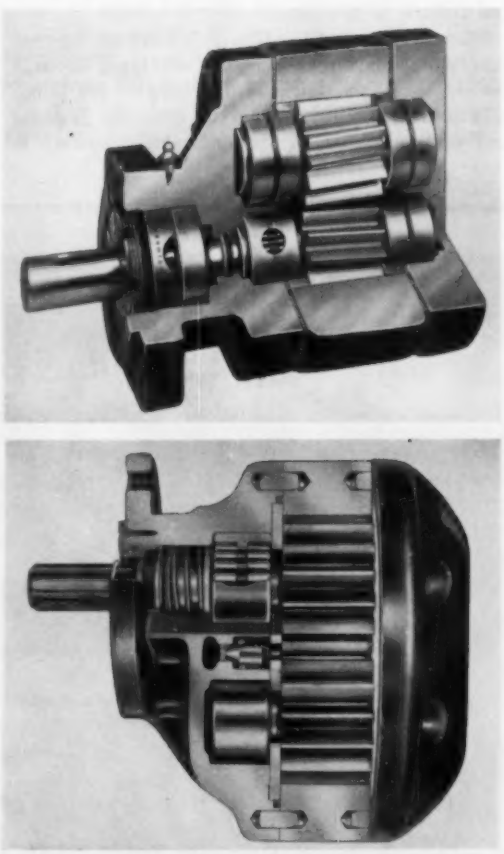


Fig. 1. TYPICAL EXTERNAL-GEAR PUMPS. One uses straight spur gears, the other helical gears. Herringbone gears may also be used.

run more quietly, but cost more.

Volumetric efficiencies of gear pumps run as high as 93% under optimum conditions. There are running clearances between gear faces, gear tooth crests and the housing which result in almost constant loss in any pumped volume at a fixed pressure, Chart 1. This means that volumetric efficiency at low speeds and volumes is poor, so that gear pumps should be run close to their maximum rated speeds.

The loss through the running clearances, or "slip", increases with pressure in these pumps. This loss is nearly constant as speed and delivery change. For the pump whose characteristics are shown in Chart 1, this loss increases by about 1.5 gpm from zero to 2000 psi regardless of speed. Change in slip with pressure change has little effect on performance when operating at higher speeds and deliveries, Chart 2. Table 1 includes typical ratings for these pumps.

External gear pumps are comparatively immune to dirty oil. It will, of course, increase wear rates and, therefore, lower efficiency, but, sudden seizure and failure do not occur.

Internal gear pumps, Figure 2, have an internal gear and an external gear. In one type, the seal between high and low-pressure sides of the pump is a crescent-shaped section between the internal and external teeth. In the other type, contact is

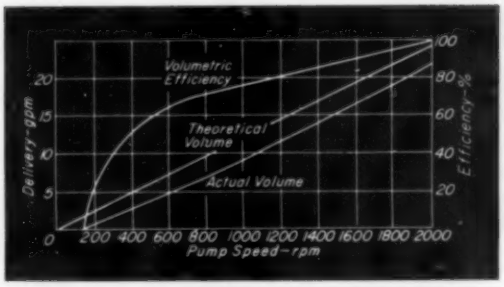

Volumetric Efficiency
Theoretical Volume
Actual Volume
Delivery - gpm
Efficiency - %
Pump Speed - rpm
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 5 10 15 20
0 20 40 60 80 100

CHART 1—AT A GIVEN PRESSURE, volumetric losses, or slip, are almost constant in an external-gear pump. Total volume pumped increases linearly with speed. Therefore, volumetric efficiency at low drive speeds is poor.

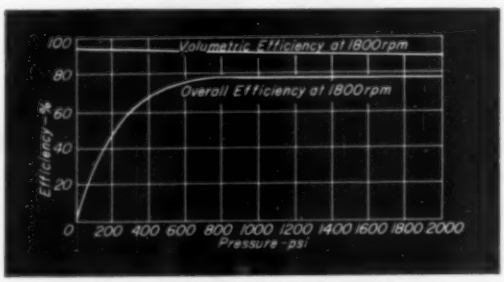

Volumetric Efficiency at 1800 rpm
Overall Efficiency at 1800 rpm
Efficiency - %
Pressure - psi
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 20 40 60 80 100

CHART 2—VOLUMETRIC EFFICIENCY and overall efficiency of a gear pump driven at 1800 rpm. With constant speed, volumetric efficiency decreases with increasing pressure. Overall efficiency is poor at low pressures because there is little work output when pressure is low and most of the input power is used to overcome mechanical friction.

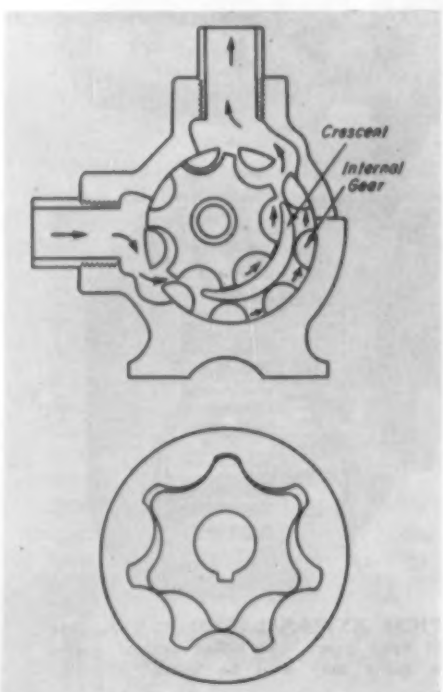


FIG. 2. PUMPING ELEMENTS of internal gear pumps.

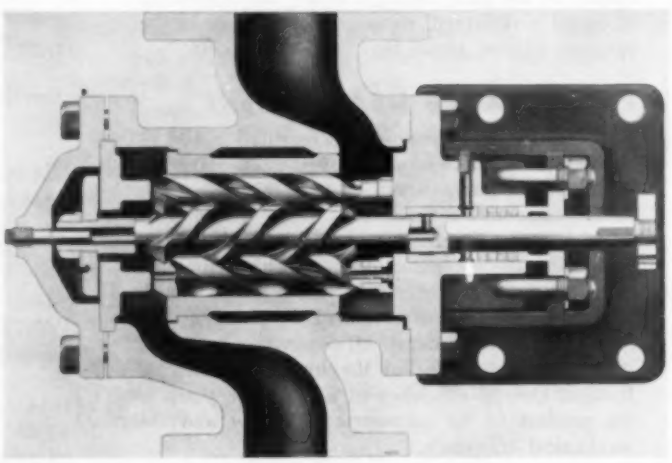


FIG. 3. SCREW AND ROTATING-PISTON PUMPS are like gear pumps in pumping method. Fluid is forced along by threads in the screw pump. In the rotating-piston pump, fluid is trapped between extended portions of rotating shafts and forced from inlet port to outlet port.

always maintained between the crests of internal and external teeth to provide the seal. These pumps are small, compact units.

Relative speeds of the inner and outer gears in these designs are low, since there are one or two less teeth in the inner gear than the outer. If the number of teeth in inner and outer gears were 10 and 11, the inner gear would turn 11 revolutions while the outer would turn 10. This low relative speed means the wear rate is low.

Generally, the internal gear pump with tooth-crest pressure sealing has higher volumetric efficiency at low speeds than the crescent type. Volumetric and overall efficiencies of these pumps are in the same general range as those of external gear pumps. Noise level is lower than for external gear pumps. Dirt sensitivity is somewhat higher. Capacity, speed and pressure ranges are given in Table 1.

There are certain other pumps whose pumping principal is like that of gear pumps. These are shown in Figure 3.

• **Vane Pumps**—Pumps of this type have a number of vanes in a rotor which rotates in a housing or ring. The housing may be eccentric with the center of the rotor or it may be oval in shape, Figure 4. In some designs, centrifugal force holds the vanes in contact with the housing while the vanes are forced in and out of the slots by the eccentricity of the housing. Light springs hold the vanes against the housing in one vane pump. As the space enclosed by vanes, rotor and housing enlarges, a vacuum is created and liquid is forced into the space by atmospheric pressure. As the space or volume enclosed is reduced, the liquid is forced out discharge ports and passages.

When centrifugal force is required to hold the vanes against the housing nad maintain a tight seal at those points, these pumps are not suited for low speed service. Operation at speeds below 600 rpm is not recommended. If springs or other methods are used to hold vanes out against the ring, efficient operation at 100 to 200 rpm is possible.

Vane pumps keep their high efficiency for a long time, because compensation for wear of the vane ends and the housing is automatic. As these surfaces wear, the vanes must move outward in their slots to maintain contact with the housing.

Vane pumps like other types come in double units. A double pump is two pumping units in the same housing. They may be the same or different sizes, Figure 5. They are mounted and driven like single pumps. Hydraulically, they are independent. Another variation is the series unit: two pumps of equal capacity are connected in series, so that the output of one feeds the other. This arrangement gives twice the pressure normally available in this make of pump.

In the variable-displacement vane pump, the volume of oil pumped can be varied while the

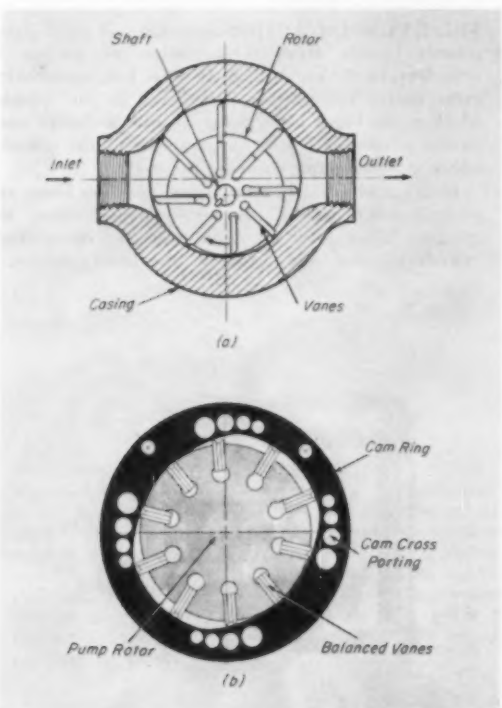


FIG. 4. IN AND OUT MOTION of vanes to suck oil in or force it out may be created by an eccentric ring, *a*, or by the ring contour, *b*. When the ring is contoured as at *b*, two inlet and two outlet ports are used. The diametrically opposite ports result in balanced hydraulic pressures on the rotor.

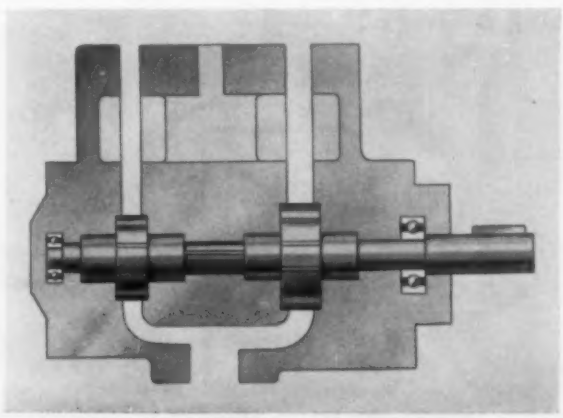


FIG. 5. DOUBLE VANE PUMP UNIT is two independent pump assemblies in a single housing. One pump is larger than the other, in the unit shown.

pump is running by shifting the housing in which the vanes run. This varies the degree of eccentricity of housing and rotor. If eccentricity is zero, delivery is zero. As the eccentricity increases, delivery increases, Figure 6. These pumps are not reversible. That is, flow direction cannot be reversed by moving the housing over-center.

Vane pumps have relatively high efficiencies, Chart 3. Their size is small relative to output. Dirt tolerance is relatively good, but not as good as that of gear pumps.

• **Rotary Piston Pumps**—Pumps of this type either have pistons arranged radially around the pump shaft (radial piston) or the axes of the pistons are parallel to the axis of the drive shaft (axial piston), Figure 7.

Efficiencies of these types of pumps are, in general, better than any of the types already discussed, Chart 4. Piston pumps offer higher pressure ratings, and a greater range of flows than gear or vane types. However, higher pressure ratings and higher efficiencies boost the cost.

Most axial and radial piston pumps lend themselves to variable-displacement as well as fixed displacement designs. Variable-displacement units are somewhat larger and heavier than the fixed-displacement units because they have added controls in a larger housing so that part of the pump can

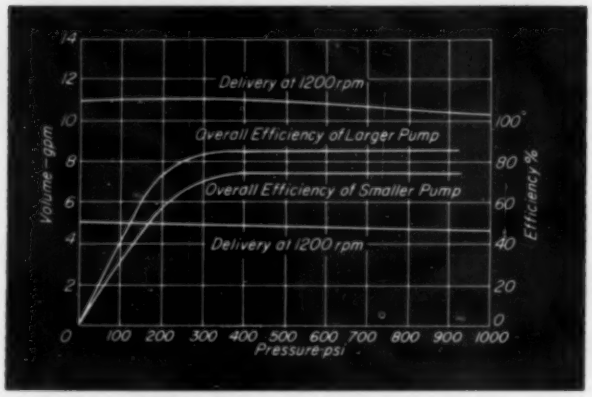


CHART 3—PERFORMANCE CURVES for typical vane pumps. Efficiency of the smaller unit is much poorer than that of the larger one. This is generally true of all types of pumps since mechanical and volumetric losses cannot be reduced in the same proportion as displacement.

be moved. Various controls such as handwheel, electric motor, hydraulic cylinder and mechanical stem can be used with variable-displacement pumps.

These pumps are more susceptible to damage from dirt or other contaminants than gear or vane pumps. Pistons, lap fitted to their bores, may be easily scored or perhaps even jammed by dirt.

• **Reciprocating Plunger Pumps**—These

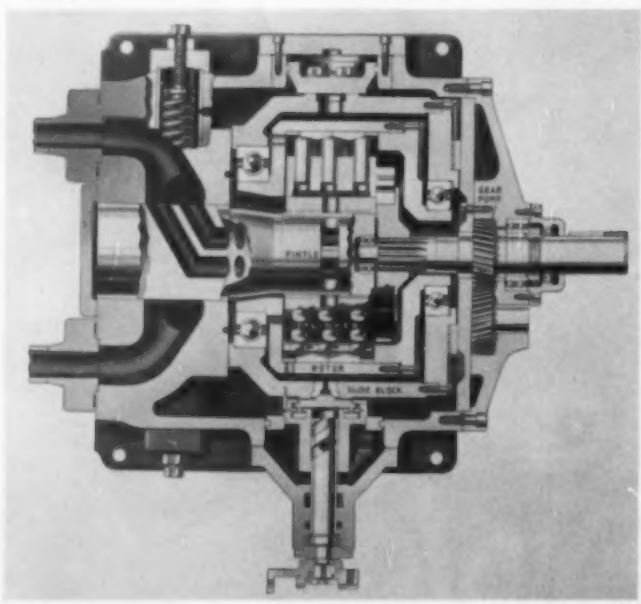
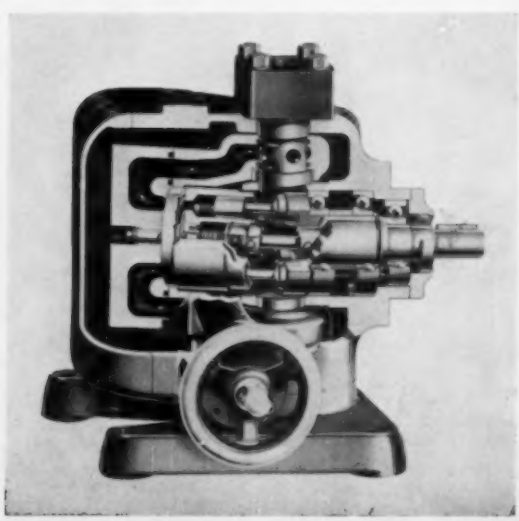


FIG. 7. PUMPING ACTION in radial and axial piston pumps results from reciprocation of pistons in cylinders. In the radial piston pump, left, an eccentric rotor moves the pistons in and out in the cylinder block as the block rotates. Intake and discharge ports in the pintle mate with the bottoms of the cylinder bores at correct times during the cycle.

In the axial piston pump, below, cylinder block and pistons rotate about the same axis. Because the cylinder block is at an angle with the drive shaft, cylinders move in and out as the block rotates.



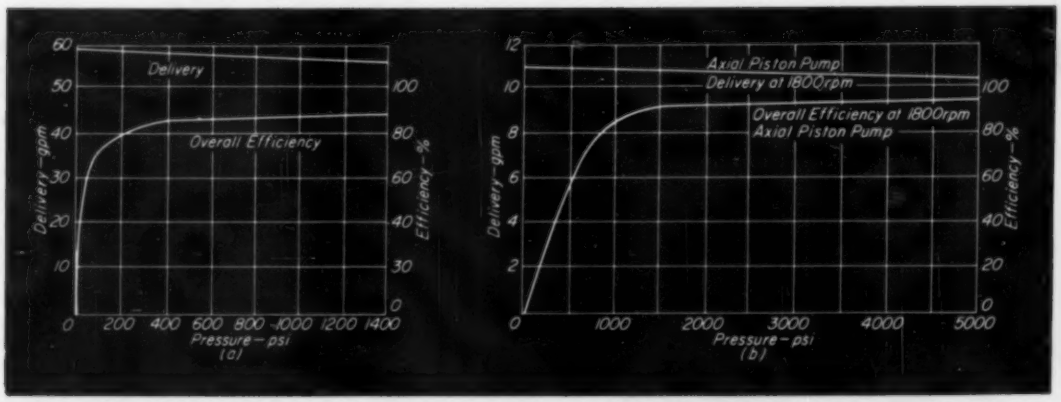
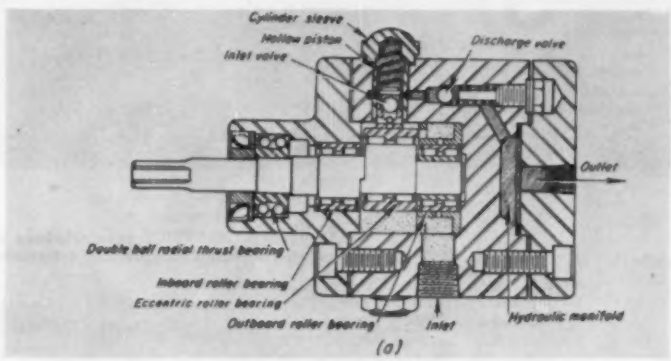


CHART 4—CURVES OF DELIVERY and overall efficiency for typical radial, *a*, and axial-piston, *b*, pumps. These pumps have high volumetric and overall efficiencies. Overall efficiencies are nearly constant over a wide pressure range.

pumps, Figure 8, are somewhat similar to rotary piston types in that pumping is the result of piston reciprocation in a cylinder bore. However, the cylinders are fixed in these pumps; they do not rotate around the drive shaft. Pistons may be reciprocated by a crankshaft, by eccentrics on a shaft or by a wobble plate. When eccentrics are used, return stroke is by springs. Because valving cannot be supplied by covering and uncovering ports as rotation occurs, inlet and outlet check valves are used in these pumps.

Because of their construction, these pumps offer two features other pumps don't have. More positive sealing between inlet and outlet permits higher pressures without excessive leakage or slip. The other feature not found in other types is that in many reciprocating plunger pumps lubrication of moving parts other than the piston and cylinder

FIG. 6. VARIATION OF THE AMOUNT of eccentricity of the ring in a vane pump will increase or decrease the amount of liquid pumped. When pressure reaches a preset value, oil pressure on a spring-loaded piston moves a plunger which bears against the ring. Since the plunger is on the high-pressure side of the ring, pressure within the ring tends to move to the ring to follow the plunger and reduce capacity of the pump.



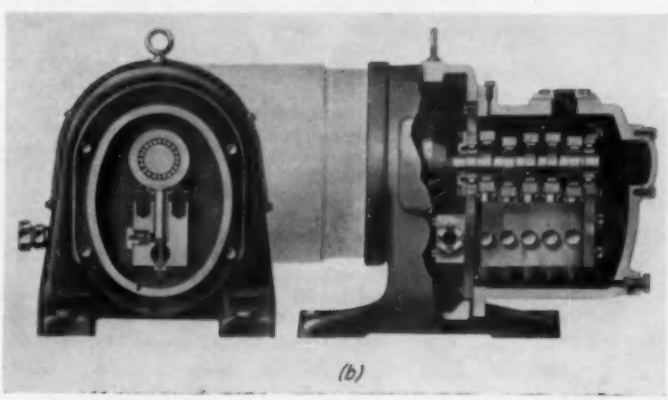


FIG. 8. TWO TYPES of reciprocating plunger pumps. Eccentrics are used to drive the plungers in these pumps.

HYDRAULIC PUMP SELECTION

bore may be independent of the liquid being pumped. Therefore, liquids with very poor lubricating properties can be pumped.

Volumetric and overall efficiencies of these pumps are close to those of axial and radial piston pumps.

SELECTION

First step in pump selection is to determine the required flow and pressure ratings for the job. With these determined, a study of available pump characteristics will show which types may be considered. Of course, any pump will work at pressures lower than maximum rated pressure. However, the pump with the higher pressure rating will cost more, all other things being equal. Therefore, it should not be used unless there are other characteristics which fit it to the job.

With the preliminary elimination of obviously unsuitable pumps out of the way, cost, efficiency and other factors must be weighed against requirements. Usually, this analysis will lead to a clear-cut decision for one type or another. ▼▼▼

TABLE I—POSITIVE DISPLACEMENT PUMP CHARACTERISTICS (INDUSTRIAL)

Pump Type	Pressure Rating Min (psi)	Pressure Rating Max (psi)	Delivery Min (gpm)	Delivery Max (gpm)	Volumetric Efficiency* Min (%)	Volumetric Efficiency* Max (%)	Overall Efficiency* Min (%)	Overall Efficiency* Max (%)	Rated Speed Min (rpm)	Rated Speed Max (rpm)	Weight Min (lb)	Weight Max (lb)	
1. External Gear	100	2500	0.2	145	70	93	51	83	1200	3600	7	530	1.
2. Internal Gear (without crescent)	1000	2000	0.24	36	50	92	36	82	1200	1800	9	50	2.
3. Internal Gear (with crescent)	150	500	5.00	300	—	—	—	—	360	1200	12	225	3.
4. Rotating Piston	300	2000	7.5	168	87	94	75	84	470	3600	77	1425	4.
5. Vane (fixed displacement)	1000	2000	1.5	77	60	96	50	94	1200	1800	11	240	5.
6. Vane (variable displacement	1000	1000	5.0	70	—	—	—	—	1200	1750	18	200	6.
7. Axial Piston (fixed displacement)	2500	5000	1.9	139	92	98	85	96	860	1750	20	370	7.
8. Radial Piston fixed displacement)	1100	3000	4.5	187	80	95†	70	91†	710	1750	175	3000	8.
9. Axial Piston (variable displacement)	600	5000	6.9	2277	92	97	88	94	400	1750	45	43,000	9.
10. Radial Piston (variable displacement)	1000	3000	0.5	187	80	95†	70	91†	710	1750	65	7800	10.
11. Reciprocating Plunger	220	20,000	0.1	1180	60	96	55	90	75	2200	183	28,000	11.

* At rated speed and pressure. † Includes auxiliary pump losses.

APPLIED HYDRAULICS acknowledges with appreciation the co-operation of the following companies in providing information used in the preparation of this article.

Adel Precision Products, Div. General Metals Corp. ....Huntington, W. Va.
American Engineering Co. ....Philadelphia, Pa.
Berry Hydraulics, Div. Oliver Tyrone Corp. (Fig. 3b) Pittsburgh, Pa.
Brown & Sharpe Co. Providence, R. I.
Commercial Shearing and Stamping Co. (Fig. 1b) ....Youngstown, Ohio
De Laval Steam Turbine Co. (Fig. 3a) ....Trenton, N. J.
Denison Engineering Div., American Brake Shoe Co. (Fig. 4b) ....Columbus, O.
Dynex Inc. ....Pewaukee, Wis.
Fawcett-Finney Ltd. ....Birmingham, England
Gerotor May Corp. (Fig. 2b) ....Owings Mills, Md.
Greenlee Tool Co. ....Rockford, Ill.
Hydraulics Unlimited Mfg. Co. ....Eaton, Col.
Hydraulic Power Div., Hydraulic Press Mfg. Co. ....Mt. Gilead, O.
Keelavite Rotary Pumps & Motors Ltd. ....Coventry, England
Kobe Inc. ....Huntington Park, Calif.
Benjamin Lassman & Son Glenshaw, Pa.
New York Air Brake Co., Kalamazoo Div. (Fig. 1a) ....Kalamazoo, Mich.
Northern Ordnance Inc. ....Minneapolis, Minn.
The Oilgear Co. (Fig. 7a) ....Milwaukee, Wis.
Racine Hydraulics & Machinery Inc. (Fig. 6) ....Racine, Wis.
Thomas Savery Pumps Ltd. ....Birmingham, England
Simplex Engineering Co. (Fig. 8a) ....Zanesville, O.
Towler Brothers (Patents) Ltd. (Fig. 8b) ....Rodley, England
Vickers-Armstrong (Engineers) Ltd. ....London, England
Vickers, Inc. (Figs. 5, 7b) Detroit, Mich.
Vickers, Inc., Marine and Ordnance Dept. ....Waterbury, Conn.
Viking Pump Co. ....Cedar Falls, Iowa
Wayne Pump Co. (Fig. 2a) ....Salisbury, Md.
Webster Electric Co. ....Racine, Wis.
Weldon Tool Co. ....Cleveland, O.
Worthington Corp. ....Harrison, N. J.

Air compressor selection

A PNEUMATIC system depends on its power supply, or compressor. A compressor increases the pressure exerted by a gas by reducing the volume. Then the gas pressure may be used to perform work.

• **Types**—Compressors used to power air cylinders and motors are either reciprocating or rotary, Figure 1. They are positive-displacement compressors because their output volume is very nearly constant regardless of changes in outlet pressure. Axial and centrifugal compressors, on the other hand, definitely vary in output as outlet pressure changes, and are rarely used for pneumatic power.

Reciprocating compressors have one or more pistons which reciprocate in cylindrical bores. There are many variations. The number of cylinders may be one or more, as in an engine. The arrangement of the cylinders takes many forms, in line, horizontal, vertical, arranged in a vee, etc., Figure 2. Furthermore, the cylinders may be either single or double acting. In a single acting cylinder, the piston compresses air only when moving in one direction. In a double-acting cylinder, air is compressed while the cylinder moves in both directions.

Usually the air enters and leaves the cylinders through check valves. In some compressors, valves are mechanically operated and open or close during part of the stroke. With check valves, the inlet check opens whenever pressure in the cylinder is below atmospheric, and closes when pressure exceeds atmospheric. The outlet check opens when pressure in the cylinder is higher than that in the tank or receiver into which the cylinder discharges, and closes when pressure is lower than tank pressure.

Rotary compressors, control intake and discharge by ports located at points of lowest and highest pressure in the cylinder walls.

• **Compression Cycles**—When air is compressed, regardless of the compressor, the action is best explained by fundamental gas laws. Boyle's Law is: *At constant temperature, the volume of a gas is inversely proportional to the absolute pressure,* or

$$\frac{V_1}{V_2} = \frac{P_2}{P_1} \qquad (1)$$

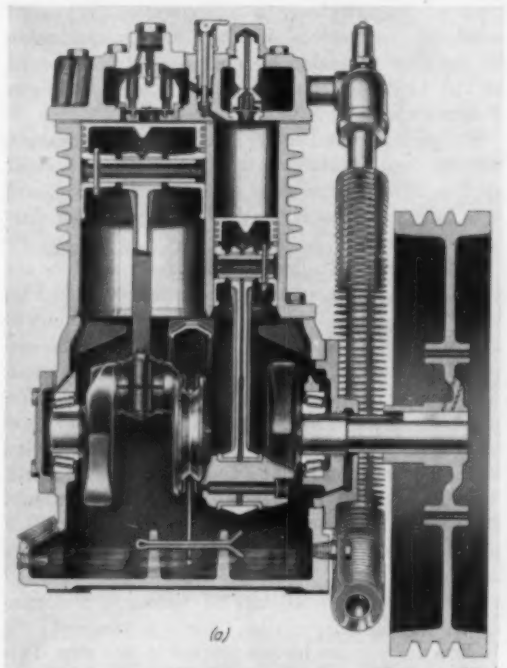
where: V_1 = initial volume
V_2 = final volume
P_1 = initial pressure
P_2 = final pressure

This equation is often written in the form

$$P_1V_1 = P_2V_2 \text{ or } PV = k$$

Charles' Law is: *At constant pressure, the volume of a quantity of gas is directly proportional to the absolute temperature,* or

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} \qquad (2)$$



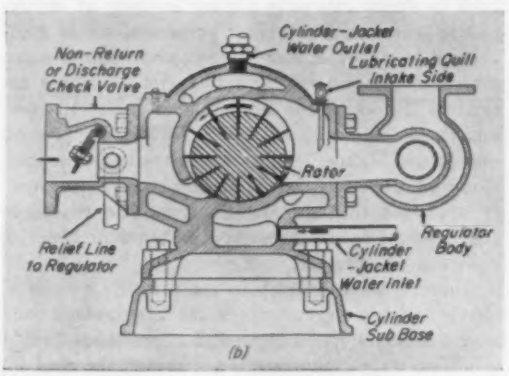


FIG. 1. Reciprocating compressor, *a*, is a piston or pistons reciprocating in a cylinder. As piston moves away from the head end of the cylinder, vacuum draws in air. As piston moves toward the head end, air is compressed and forced out. Rotating vane compressor, *b*, has vanes in slots in a rotor which is eccentric with the cylinder bore. When vanes are fully extended, area between vanes and end plates fills with air at atmospheric pressure. As the rotor turns, vanes are forced inward compressing the air.

AIR COMPRESSOR SELECTION

Equations 1 and 2 may be combined to give

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad \text{.....(3)}$$

Another important fundamental is that compressing any gas, heats it. For air, if all the heat of compression remains, pressure and volume vary according to the formula

$$PV^{1.4} = k \quad \text{.....(4)}$$

The same relationship is true for expansion. This type of expansion or compression is called *adiabatic*. Conversely, in *isothermal* compression all the heat generated by compression is removed as fast as it is created, so temperature of the gas does not change.

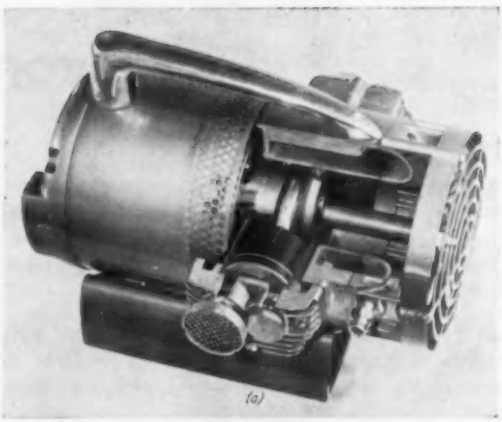
Truly isothermal and adiabatic cycles cannot happen since, in practice, it is impossible to prevent all flow of heat from a gas during compression, and it is impractical to remove all heat generated during compression.

Isothermal and adiabatic compression cycles are compared with an actual compression cycle in Figure 3. Work done in compression is proportional to the area bounded by ABCD for isothermal compression and AECD for adiabatic compression. Since more work is required for adiabatic compression, as much heat as possible is removed from air during compression. Compressors are cooled either by fans and cooling fins or by water jackets. This increases efficiency and limits temperature for safety. Adiabatic compression of air at 60 F and 14.7 psia to 150 psig results in a temperature of 570 F.

Because of the difficulty of removing heat generated during compression, there is a practical limit to how far air can be compressed in one step. This limit is about 100 psig for air initially at atmospheric pressure. For higher pressures, air is compressed in stages. A multi-stage compressor is more than one compressing unit built into a single assembly. Output of the first stage is fed to the second stage, Figure 4, where it is further compressed and so on. Figure 5 shows how two-stage compression makes the actual compression curve more closely approach the isothermal curve. The reason is that cooling occurs between the stages in a device called an intercooler.

There is some overlap in the pressure ranges of single and two-stage compressors. Single-stage compressors are sometimes used for pressures to 150 psi. Two-stage compressors are sometimes used for pressures as low as 80 psi. Cost makes the difference.. Theoretically a two-stage compressor uses 20% less power than single stage. Therefore, the higher cost of a two-stage compressor cost may be justified by decreased power consumption when operating for long periods.

Operating pressure range of two-stage compressors is about 80 to 500 psi. Three stages are used from 500 to 2500 psi and four stages from 2500 psi up.



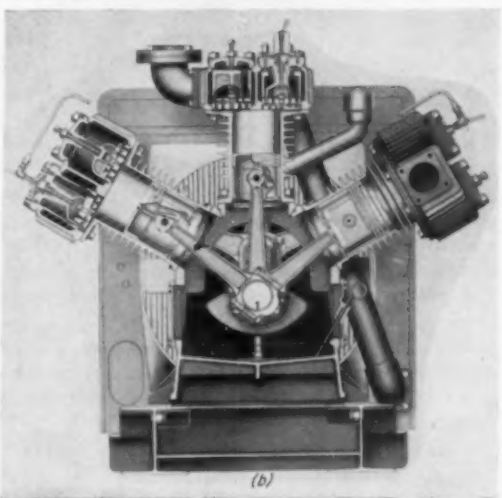


FIG. 2. Some of the possible variations in compressor construction are illustrated by these Y and horizontally opposed compressors. All are single-acting, air-cooled, reciprocating types.

• **Compressor Ratings**—Many manufacturers publish theoretical displacement of their compressors but not actual capacity. There are many reasons why capacity cannot equal displacement—leakage past piston rings and piston rods, cylinders not completely evacuated at the end of the piston stroke, etc. When capacity is not given it is only safe to assume that actual output is from 50 to 80% of displacement and then ask for the true figures.

When actual capacity of a compressor is given, it is ordinarily in cubic feet per minute of free air. Free air is defined as air at atmospheric conditions at any specific place. Since temperature, pressure and moisture content of air vary, there is nothing standard about free air. However, it is what the compressor has to work with. Output is measured in this way because the value remains constant in spite of variations in inlet conditions.

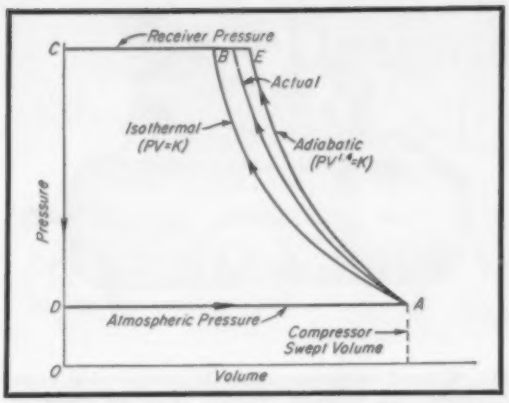


FIG. 3. Adiabatic, isothermal and actual compression cycles.

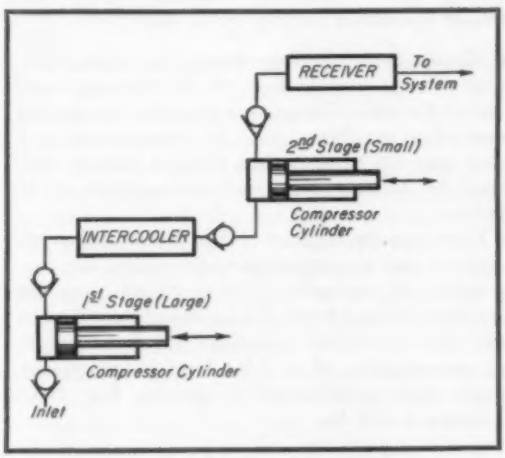


FIG. 4. Diagram of a two-stage compressor.

TABLE I—INDUSTRIAL AIR COMPRESSOR CHARACTERISTICS

Compressor Type	Max Pressure Rating Range Min (psi)	Max (psi)	Displacement Range Min (cfm)	Max (cfm)	Capacity, Free Air Range Min (cfm)	Max (cfm)	Max Drive Speed Range Min (rpm)	Max (rpm)
1. Reciprocating Single-Stage, Air-Cooled, Single-Acting	—	150	1.72	735	—	—	700	1750
2. Reciprocating, Two-Stage, Air-Cooled Single-Acting	100	1000	1.90	735	—	—	350	1750
3. Reciprocating, Three-Stage Air-Cooled, Single-Acting	250	3500	13	44	—	—	580	1100
4. Reciprocating, Single-Stage, Water-Cooled, Single-Acting	—	150	32	184	—	—	—	870
5. Reciprocating, Two-Stage, Water-Cooled, Single-Acting	100	1000	27	1150	—	—	—	870
6. Reciprocating, Single-Stage, Water-Cooled, Double-Acting	—	150	80	2200	—	—	277	450
7. Reciprocating, Two-Stage Water-Cooled, Double-Acting	110	500	87	13400	—	—	277	600
8. Reciprocating, Three-Stage, Water-Cooled	1500	2500	63	311	—	—	250	350
9. Rotary, Two-Stage, Air-Cooled	—	125	—	—	85	900	—	1900
10. Rotary, Two-Stage, Water-Cooled	—	120	—	—	112	1600	575	1750
11. Rotary, Piston Rotary, Single-Stage	—	85	—	—	22	450	1750	3500

In addition to these standard sizes, special compressors are available for pressures to 15,000 psi and capacities to more than 18,000 cfm.

Because compressor capacity is given as free air, it is convenient to convert air requirements to free air during sizing calculations. This can be done with Equation 3.

For example, if air at 100 F and 100 psig were taken at the rate of 2 cfm, from a receiver, and compressor inlet conditions were 14.7 psia and 60 F, free air consumption would be

$$\text{cfm} = V_i = \frac{P_c V_c T_i}{T_c P_i} = \frac{114.7 \times 2 \times 520}{560 \times 14.7} = 14.5$$

To illustrate the effect of inlet conditions on free air consumption, let's calculate free air consumption for the same conditions at the actuator but with inlet pressure of 14 psia. Then

$$\text{cfm} = V_i = \frac{114.7 \times 2 \times 520}{560 \times 14} = 15.2$$

In both of these examples it is assumed that air in the receiver was at higher than ambient tem-

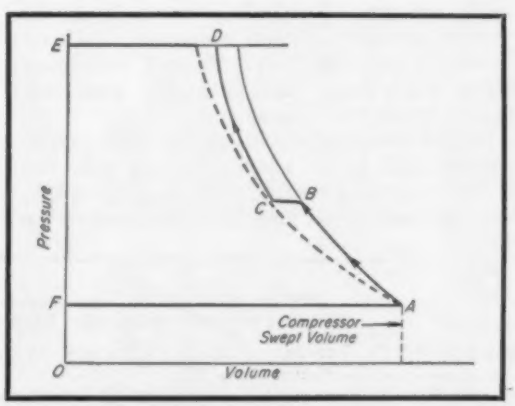


FIG. 5. Two-stage compression with intercooling reduces power required for compression because compression curve more closely approaches the isothermal curve.

perature. This would not be true if air remained in the receiver long enough to cool to ambient temperature, or an aftercooler were installed. If the air used in this application were cooled to inlet temperature with all other conditions the same as the first example, free air consumption would be

$$cfm = \frac{114.7 \times 2 \times 520}{520 \times 14.7} = 15.6$$

• **Reservoirs**—Output of a single-cylinder, single-acting, reciprocating compressor is pulsating. Of course multiple, double-acting, cylinders produce a much smoother discharge. Nevertheless, reservoirs or tanks are used for several reasons. A tank smooths compressor discharge and makes it possible to use a compressor whose output equals average air demand rather than the maximum instantaneous demand. A tank also serves as a place for air to cool and, therefore it is a moisture separator. Moisture is always present in air and it will condense out if the air is cooled enough.

• **Controls**—Small compressors driven by electric motors are usually regulated by a start-stop control. This is a pressure switch that starts and stops the motor. When outlet pressure rises to the set value, the pressure switch stops the motor. When enough air is used so that pressure drops to some lower value, the switch restarts the motor. Pressure regulation is not precise with this system but is adequate for many jobs. Pressure differential or the difference between pressure at which the drive motor stops and that at which it starts is usually 20 psi or more.

In applications where it would be inconvenient to start and stop the motor or engine driving the compressor, unloaders are used. Unloaders may be *on-off* or variable. An unloader is a valve or valves which either cut off or reduce the flow of air to the receiver and at the same time reduce the amount of work done by the compressor. For example, one type of unloading system blocks the receiver port and connects compressor discharge directly to the intake port. Although compressor pistons continue to reciprocate, they work only against atmospheric pressure.

Stepped unloading is quite common on large compressors (150 hp or more). Five-step unloading lets the compressor operate at full-load, ¾ load, ½ load, ¼ load or no load while being driven at constant speed. Three-step unloading lets a compressor operate at full, ½ or no load.

FIG. 6. Small compressors may be purchased as units complete with reservoir. Vertical types are made as well as the horizontal type shown.

• **Compressor Sizing**—Remember when planning a large system that all the devices won't run all the time. Compressor capacity calculations must allow for this. Actual air consumption in a plant may not be more than 15% of what is indicated by totaling maximum consumption of all devices.

Total capacity required is then determined pretty much by previous experience with usage. Air consumption of pneumatically powered machines can be computed from bores and strokes of the cylinders used and the machine operating cycle. For example, air consumption of a 2-in. bore, 12-in. stroke, single-acting cylinder which operates four times a minute would be:

$$cfm = \frac{\pi d^2 L}{4 \times 1728} \times 4 = \frac{\pi \times 4 \times 12}{4 \times 1728} \times 4 = 0.087$$

The figure 1728 converts cubic inches to cubic feet. Since this figure is at operating pressure, and compressor capacities are in terms of free air, this is then converted to free air using Equation 3. Temperature can be ignored if receiver temperature is the same as ambient.

With air requirement determined, a good rule-of-thumb to follow for industrial applications, is: Select a compressor with from 30 to 50% excess capacity. This will give you enough margin so a little leakage won't hurt and it'll let a few more tools or cylinders be added without adding more compressors. ▼▼▼

APPLIED HYDRAULICS acknowledges with appreciation the co-operation of the following companies in providing information used in the preparation of this article.

Bell & Gossett Co. (Figs. 2a.) ..... Morton Grove, Ill.
Brunner Div., Dunham-Bush Inc. ..... Utica, N. Y.
Cooper-Bessemer Corp. ..... Mount Vernon, O.
Chicago Pneumatic Tool Co. ..... New York, N. Y.
Curtis Mfg. Co. (Fig. 1a) ..... St. Louis, Mo.
Davey Compressor Co. ..... Kent, O.
De Vilbiss Co. ..... Toledo, O.
Fuller Co. (Fig. 1b) ..... Catasauqua, Pa.
Gardner-Denver Co. (Fig. 2b) Quincy, Ill.
Le Roi Div., Westinghouse Air Brake Co. (Fig. 6) ..... Milwaukee, Wis.
Ingersoll-Rand Co. ..... Phillipsburg, N. J.
Nash Engineering Co. ..... South Norwalk, Conn.
Quincy Compressor Co. ..... Quincy, Ill.
Wayne Pump Co. ..... Fort Wayne, Ind.
Worthington Corp. ..... Harrison, N. J.

Designing with gas-oil accumulators

Want to use a smaller pump, damp surges, get faster speeds? Then consider an accumulator for your system.

WHEN an accumulator is needed on an industrial machine, a *hydropneumatic* or gas-oil type is usually picked for the job. Basically this is a secondary reservoir connected into the main system and pressurized by compressed gas, usually nitrogen.

These accumulators differ in design mainly in the way which the fluid is separated from the gas. In larger accumulators, or air bottles, for central hydraulic systems, there may be no barrier between the air and water. To keep the compressed air out of the system, a minimum water level must be maintained as a seal. The volume of this non-working fluid adds to the size of the accumulator. While this is not objectionable in the larger units equipped with adquate level controls, accumulators for machine mounting must be compact and function without external controls.

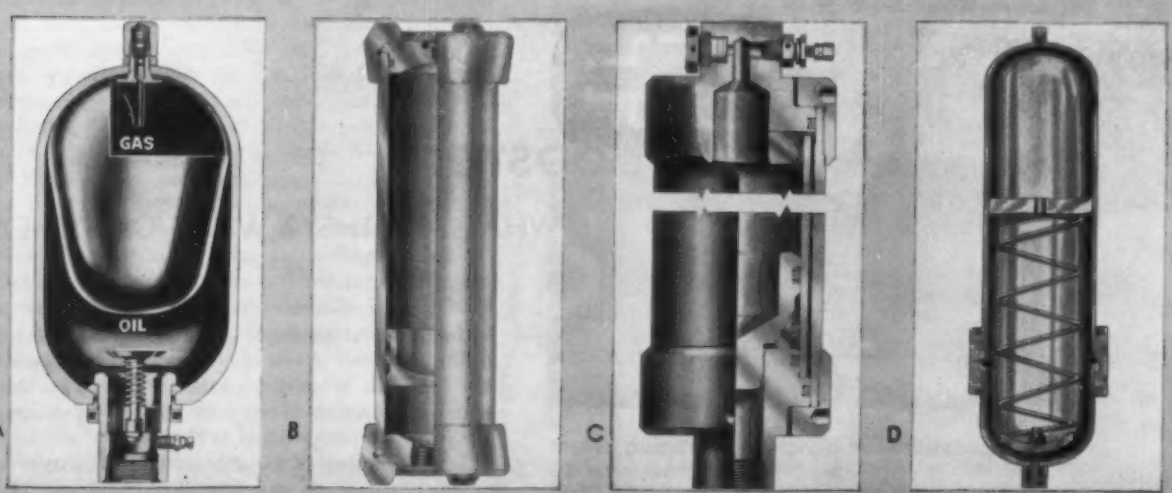
• **Piston Type**—Air-oil accumulators having a separator are divided into piston and flexible separator types. The piston type is similar to a hydraulic cylinder without piston rods, the piston "floating" between the hydraulic fluid and the compressed gas. The piston travels according to fluid flow into or out of the accumulator, and the gas expands or contracts to balance fluid pressure. The piston is frequently sealed with O-rings. In one design, Teflon guide rings are used with a V-O-ring which combines the advantages of a V-ring and O-ring.

Piston accumulators are rated according to their maximum oil volume without an air charge. Actual fluid storage is less than this because of the volume occupied by the compressed gas. An advantage of the piston type accumulator is its ability to deliver all the stored fluid with the piston bottoming against the end of the cylinder.

• **Double Shell**—Designing a piston accumulator with a double shell construction provides a pressure-balanced inner shell. The outer shell acts as a gas container and protective cover, so that small dents do not interfere with free movement of the piston. This design is also used in aircraft accumulators to reduce wall thickness and weight. Similar protection against dents in single-shell accumulators is obtained by using a heavy wall cylinder.

A feature of the double-shell accumulator is that rapid decompression of the gas with rapid discharge of the fluid cools the entire working area of the inner shell. This is especially important during rapid cycling.

The piston of the accumulator seals with two O-rings and has pressure balancing ports to equalize pressures on both sides of the O-rings. This eliminates any pressure lock between the O-rings. A dashpot decelerates the piston at the end of its stroke, so that the entire volume of the unit can be used without hammer.



FOUR ACCUMULATOR DESIGNS. In the type shown in (a), *Greer Hydraulics, Inc.*, the compressed gas is held in a synthetic rubber bladder. Poppet at fluid port prevents bladder extrusion. Single-wall piston type is shown in (b) *Parker Hydraulics Div., Parker-Hannifin Corp.* Piston seals with V-O-ring and has Teflon guide rings. Double shell, piston type in (c), *Superior Hydraulics*, balances pressures on each side of the inner shell by using outer shell to contain gas. Rubber diaphragm seals accumulator shown in (d) *Special Products Co.* Snap ring fastens shell.

GAS-OIL ACCUMULATORS

USE ACCUMULATORS TO:

- Make up leakage in a holding operation while the pump is unloaded.
- Absorb line shock, reduce pressure peaks, smooth out pump pulsations.
- Operate secondary circuits when the cycle permits storing sufficient fluid.
- Provide standby power if pump fails.
- Supply extra fluid for fast cylinder speed.

• **Bladder Type**—The bladder or bag type accumulator holds compressed gas in a synthetic rubber bladder mounted in a cylindrical shell. Stored oil fills the remainder of the shell, collapsing the bladder until pressures are balanced between the system fluid and the compressed gas.

Because of the bladder's low inertia, and its large surface area, this accumulator is especially good for absorbing line shocks. It has the necessary fast action to take a high rate of flow for a short time.

Ratings of bladder type accumulators range from one pint to 10 gal. This indicates the total volume of the shell. However, for longest service life, especially in rapid cycling operations, the bladder should not be compressed to less than one-third the total volume of the shell or expanded to more than two-thirds the total volume. For example a 10-gal. accumulator precharged to 1000 psi and operating between system pressures of 3000 and 1500 psi will deliver 450 cu. in.

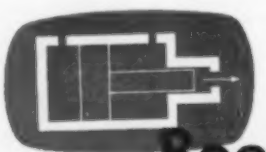
A spring-loaded poppet prevents extrusion of the bladder through the fluid port if the fluid is completely exhausted. This poppet is normally open and is closed by the bladder in the fully extended position. The bottom of the poppet contains a piston which fits into a dashpot. This damps fast opening of the poppet and prevents shock when opening under extremely high flow.

Recommended mounting position for the bladder type accumulator is vertical with the fluid port down. The unit may also be mounted horizontally.

• **Diaphragm**—The accumulator design shown in (d) of the figure separates oil and gas by a spring-loaded rubber diaphragm. The outside shell is in two sections held together by a snap ring for easy maintenance. These sections also hold a flange molded on the diaphragm to form a seal between fluid and gas. Plates bolted to the diaphragm prevent extrusion through the fluid port, and also direct fluid to start the rolling action on the sidewalls of the diaphragm. This rolling action eliminates friction and gives long service life of the accumulator. The accumulator is rated at 3000 psi and 600 cu. in.

• **Maintenance**—Gas-loaded accumulators need regular recharging, usually with dry nitrogen, and they have built-in valves for this purpose. Maintenance equipment should include a charging hose with fittings for a nitrogen bottle and accumulator valve, and also a gage to indicate precharge pressure.

In piston accumulators, the condition of the piston seal is determined at periods depending on the duty cycle of the system. To make this check, the accumulator is shut off from the system, and the piston allowed to bottom. Gas pressure is then measured against the specified value. A pressure increase indicates leakage of oil into the gas side; a pressure drop indicates leakage of gas into the oil side. A large difference between actual and specified pressure indicates the need for a new piston seal. ▼▼▼



Boosters

WHAT ARE THEY? WHAT CAN THEY DO?

If you need limited flow at high pressure, check whether a booster can do the job. They make a low cost, compact installation for operations like punching, clamping, riveting, and pressing.

BOOSTERS increase hydraulic pressure by a fundamental principal of fluid power. *Forces acting on a body at rest or moving at constant speed are balanced.* When these balanced forces are due to pressures acting on two different areas, pressures are inversely proportional to the areas.

In its simplest form, a booster is similar to a cylinder whose rod end is enclosed and acts like

Reciprocating air-oil boosters shown on these arbor presses are mounted on their own reservoirs with air and oil controls. The single-plunger booster is driven by an automatically cycled, 6-in. diameter air cylinder. This installation is especially effective on small presses which require maximum pressure for only a short part of the stroke. Maximum output pressure within the range of the booster ratio is controlled by adjusting inlet air pressure. Maximum pressures to 30,000 psi can be obtained with 100-psi air, and special models are rated at 50,000 psi.

A feature of reciprocating boosters is that they can stall during a holding operation without consuming power. The booster operates only to make up leakage. On bottoming, the ram of this booster returns immediately for another stroke. Even in most plastic or rubber molding processes, the momentary dip in pressure caused by this return stroke causes little if any trouble in the product.

Courtesy Sprague Engineering Corp.

a ram type cylinder. Force acting on the main piston is balanced by force acting in an opposite direction on the ram. Therefore pressures are inversely proportional to the ratio of piston area and ram area.

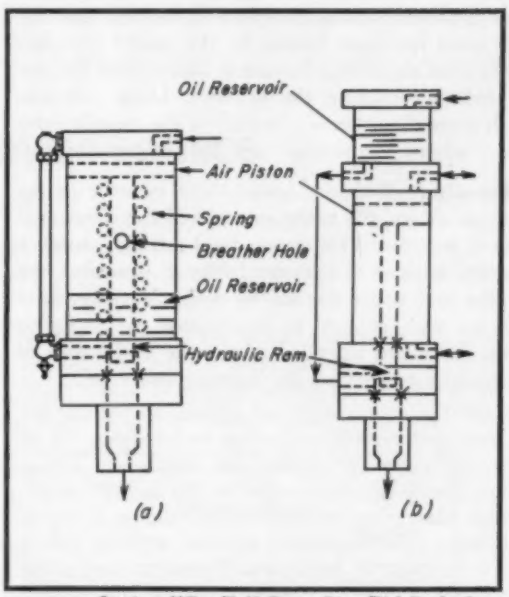
Two basic types of boosters are in use: single stroke and reciprocating. Either may have an air input and oil output, or oil input and output.

SINGLE STROKE BOOSTERS

Single stroke boosters may be either single pressure or 2-pressure as diagrammed in Figure 1. The single pressure unit, illustrated in (a) is actuated by air pressure acting at the top port against the piston. This forces the piston down through the seal and compresses the fluid in the lower section. The piston is returned by the spring when the top port is exhausted. Reserve fluid in the cylinder makes up for any loss during each stroke. The air breather holes in the side of the cylinder assure atmospheric pressure in the rod end of the main cylinder.

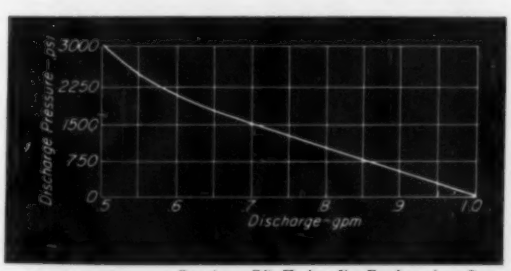
The single pressure booster is used where the work cylinder approach stroke is short in comparison to its work stroke. Where the approach stroke is comparatively long, the 2-pressure booster, shown in (b) of Figure 1 is best because it lets the work cylinder advance at low pressure without using the booster. This saves air. Air or oil pressure, applied at the top port, acts against the reservoir fluid. With the ram fully retracted, this pressure is applied directly to advance the work cylinder. When the work is contacted, input pressure applied to main piston, starts booster action.

Single-stroke boosters may be either single acting or double acting depending on whether air (or oil) is ported to the rod end of the piston to return it. Single-acting boosters may be returned by an internal spring or by some external means. Spring-return boosters save the air required for return, but require extra power to compress the spring on the advance stroke. They must be longer than double acting boosters because of the housing needed for the spring. An air-saving method for double-acting boosters is to use a pressure reducing valve in the return line, so that the booster is retracted at low pressure.



Courtesy Miller Fluid Power Div., Flick-Reedy Corp.

FIG. 1. SINGLE STROKE BOOSTERS for single pressure operation (*a*), and 2-pressure operation (*b*). Single pressure unit is used where advance stroke is short. 2-pressure unit is best where advance stroke is long. It can also be spring returned.



Courtesy SC Hydraulic Engineering Corp.

FIG. 2. DISCHARGE of an air-oil reciprocating booster for operation to 3000 psi. Other models have linear characteristics to maximum pressure ratings.

RECIPROCATING BOOSTER

Reciprocating boosters are often called pumps, because they deliver a continuous flow as long as output pressure does not exceed a value depending on input pressure and booster ratio. Delivery from these boosters is inversely proportional to output pressure, and a typical output curve is shown in Figure 2.

To get the self-reciprocating action, these boosters use cam-actuated, electrically actuated, or sliding type 4-way valve to direct air or oil alternately to each side of the main piston. This valve is shifted at each end of the piston stroke. When the work cylinder meets a solid resistance and stalls, the booster also stalls. If pressure drops because of leakage, the booster will again operate to maintain pressure.

Maximum pressures of reciprocating boosters range to 30,000 psi in one air-oil type with a 100-psi air input. Higher pressures are possible with special models. In an oil-to-oil type, maximum pressures range to 5000 psi, with a pressure ratio between outlet and inlet of 7:1. ▼▼▼

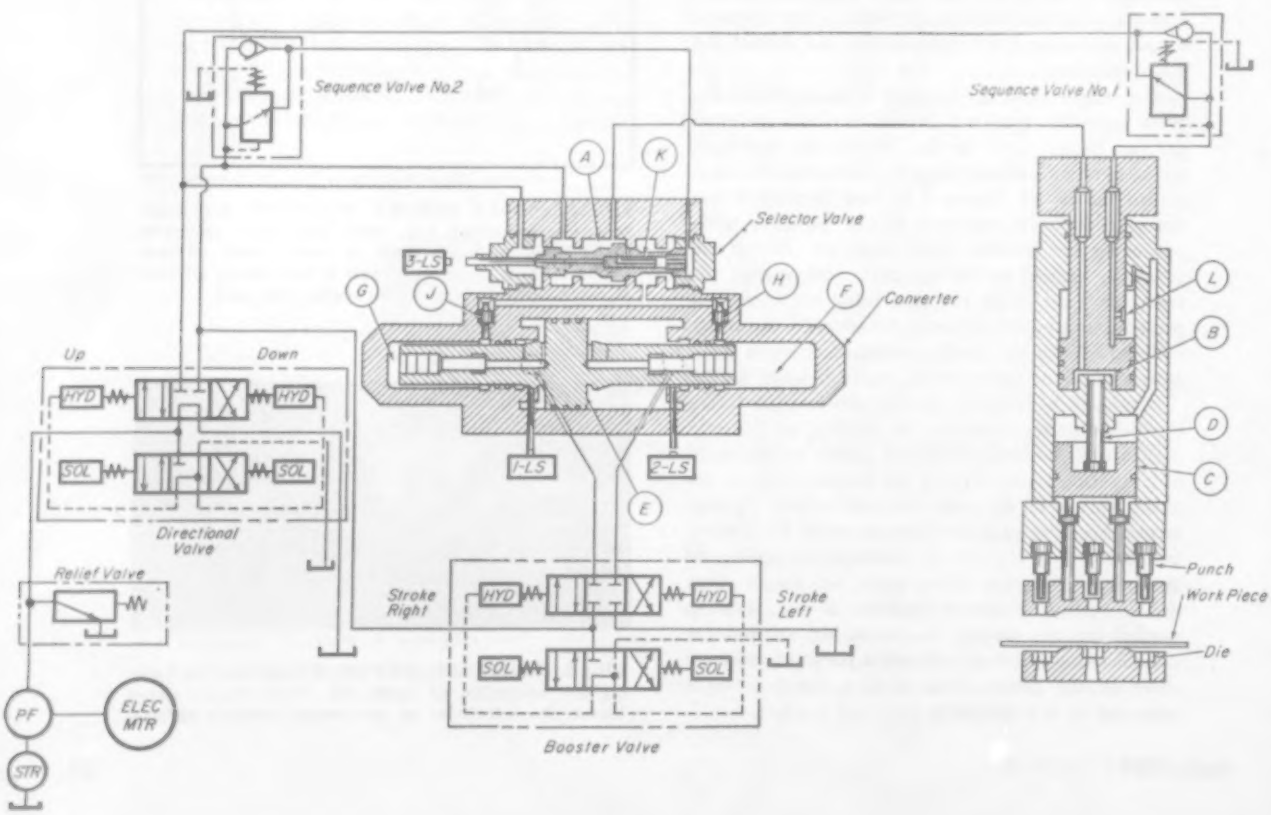
HIGH FORCE PUNCH

The booster in this system supplies a continuous flow of oil at pressures to 10,000 psi for punching after the work piece has been formed by the special cylinder. The booster also has a feature to decompress the circuit before retracting the cylinder. Limit switches, which sense the extreme positions of the main booster piston, actuate the booster valve for reciprocation.

• **Forming**—With the booster and cylinder in the positions shown, the DOWN solenoid of the directional valve is actuated. This directs fluid through chamber *A* of the booster to cylinder cavity *B* extending the cylinder and upper die for forming. Sequence valve 1 is set high enough to insure that the stripping piston *C* remains extended during the downstroke of the cylinder to perform the forming operation.

• **Punching**—As pressure rises after forming, sequence valve 2 opens, porting fluid to the booster selector valve and shifting the selector piston to the left. This closes the low pressure passage through chamber *A* and opens the passage from chambers *G* and *F* in the main booster. Fluid from the directional control valve is alternately ported to chambers *G* and *F* and through the booster valve to corresponding sides of the piston. Output of the booster is through chamber *A* to the cylinder.

The cylinder advances through its punch stroke until the directional valve is shifted for the upstroke. Fluid is then directed through the axial hole in the selector piston to shift piston *K* to the right. This connects high pressure in the cylinder to tank for decompression. Fluid from the high pressure side of



WHEN TO USE A BOOSTER

1. In portable applications where space and weight are limited. A high pressure booster and cylinder can deliver the same force as a much larger cylinder working on low pressure.
2. Where pressure must be held for a long time, such as in rubber and plastic molding. Air-oil boosters use no power while holding pressure. Pump unloading or pressure compensating methods are eliminated along with the heat problem.
3. When very high pressures are regulated such as for hydrostatic testing.
4. To save installation costs by eliminating a hydraulic power unit. This is a special advantage where the set-up is temporary.

the cylinder and chamber *A* in the booster bleeds off through a decompression port in piston *K* and drains to tank through the right end of the selector piston. The selector piston remains locked in its extreme left position by high pressure oil until the pressure in chamber *A* has dropped sufficiently to permit oil pressure on the left to move the piston to the right. This connects chamber *B* of the cylinder to tank through the selector valve and permits the cylinder to return at normal operating pressure without shock.

Information supplied by J. R. Danly, Chief Development Engineer, Danly Machine Specialties, Inc., Chicago, Ill.

EMERGENCY POWER SOURCE

Large heat treating furnaces have hydraulic cylinders to open the doors, push in the parts, and move the parts within the furnace. In addition to the main pump, some emergency source of hydraulic power must be installed so that the furnace doors can be opened in case of electrical failure in the plant. This is to remove the parts in process and vent the furnace of gases.

In the past, furnaces made by Surface Combustion Corp. were equipped with a hand pump for this purpose. Because of the slowness and hard work of operating with this pump, engineers have replaced it with a reciprocating air-oil booster unit. This unit is constructed from a standard booster, 4-way air valve, and air-line filter-regulator-lubricator controls.

The valve and air-line controls are mounted on a bracket over the booster. To prevent excessive pressure, a safety air valve has been installed between the regulator and 4-way valve. This valve opens at 50 psi and closes at 45 psi limiting hydraulic pressure to 1200 psi. Check valves are also installed on the booster unit, so that the two outlets and two inlets can be piped to common lines. The complete unit measures 31 x 11 x 17 inches.

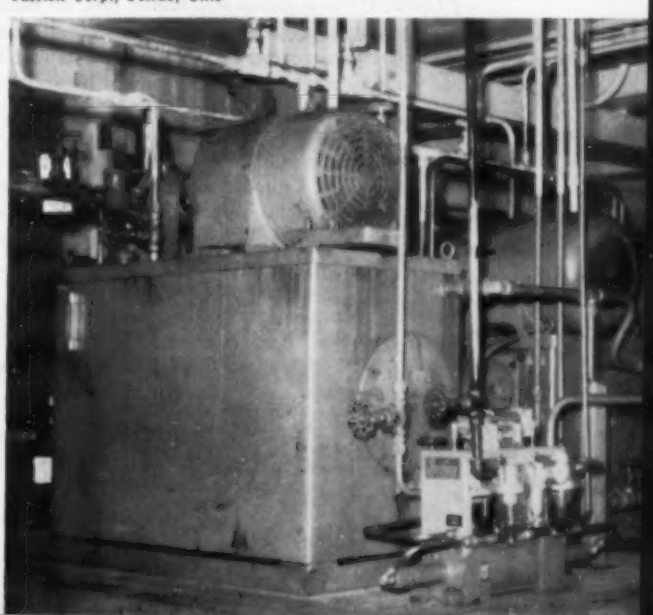
• **Performance**—The booster output is 2¼ gpm at 960 psi when supplied with air at 40 psi. It requires 21.8 cfm of free air per minute. A common, door-actuating cylinder has a 2½-inch bore and 27-inch stroke. When supplied by the booster unit, this cylinder opens the door in 13 seconds.

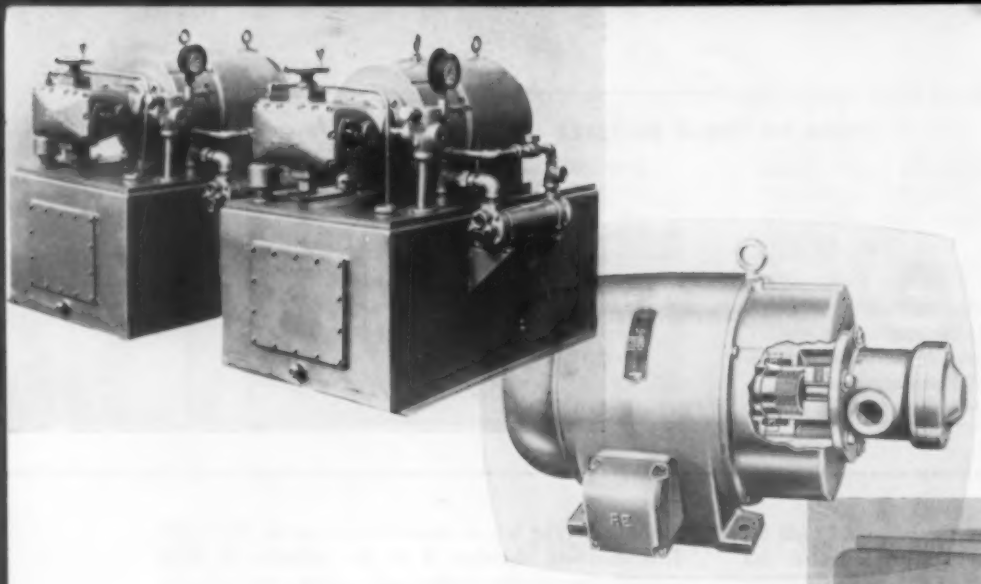
Until all cylinders have completed their strokes, the booster reciprocates at the rate of 112 strokes a minute and delivers full volume to the system. When all cylinders have bottomed, the booster stalls and maintains maximum pressure. However because of internal slippage past piston rings in the furnace cylinders, and past sliding spools in the valves, the booster continues to *creep*, delivering just the amount of oil necessary to make up for leakage and maintain pressure. Ordinary slippage causes the pump to stroke at 6 to 10 strokes a minute depending on the age and efficiency of the system.

After priming, the booster will *lift* several feet, but for safety, it should be mounted level with the oil reservoir so that it is flooded.

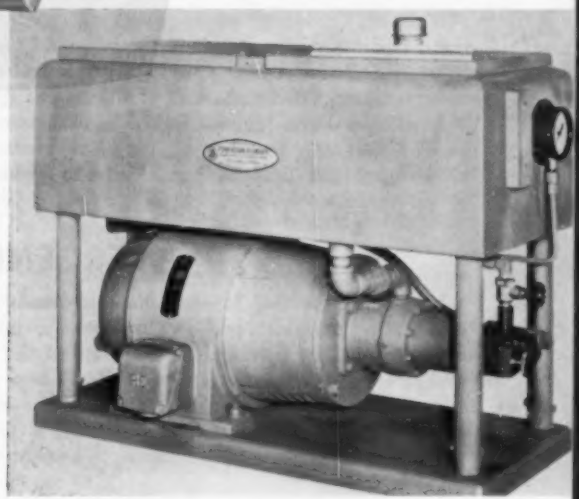
• **Air Supply**—The power source for the unit may be nitrogen bottles, plant air supply, or an air receiver. Two 224-cu. ft. nitrogen bottles will operate the pump continuously for approximately 20 minutes. If the compressors are steam driven, the plant air system can supply the booster. A 100-gallon air receiver filled at 120 psi will operate the pump approximately 5 minutes. A check valve installed at the inlet to this receiver prevents loss of air if the compressor fails. Two or three furnaces can be operated by one booster unit by interconnecting the pressure headers and return lines.

Information supplied by Harold Yarnell, Engineer, Surface Combustion Corp., Toledo, Ohio





TOP VIEW shows compact power units combining variable volume pumps close-coupled to motors. View at left shows vane type pump mounted directly on the motor. Arranging the power unit under the reservoir, below, insures adequate fluid supply to the pump.



Here's a new development that will help you cut costs in assembling power units. Maintenance is also simplified with a . . .

Close-coupled pump-motor

• By James A. Morrison, *Reuland Electric Co., Alhambra, Calif.*

COMBINING a pump and motor into an integral unit makes it simple to get perfect alignment, even by inexperienced maintenance personnel. This precise alignment gives longer pump life and eliminates air leaks at the pump seals.

Recently developed electric motors now permit close coupling almost every brand of pump manufactured in the United States. Early motor models in this development were simply NEMA, Type C end-bracket designs with specially machined adaptors. Later, certain castings were included on the flange, and shafts were machined to match the mating hydraulic pump. The wide demand for these prompted the design of a motor in the new re-rated frames engineered specifically for hydraulic pump mounting.

• **Motor Design**—The new motor has a splined drive to the motor shaft and a conventional, coupling-half for the pump shaft. The coupling is mounted on the pump shaft as usual, and the complete unit is slipped on the splined shaft of the motor. This design has not only simplified the mounting, but has also eliminated special shaft lengths and diameters.

• **Smaller Reservoir**—When a conventional motor and pump are mounted on a reservoir, its top must be long enough to support the components. With the close-coupled pump-motor, the reservoir length can often be shortened by 10 or 15 inches. Even if oil volume requirements prevent any reduction in reservoir size, its shape can be designed for better use of floor space. To maintain alignment of the conventional motor and pump, the top must be of heavy plate or stiffened with fabricated

Fluid power from three pumps in tandem works independently or in combination

Three COMMERCIAL heavy-duty pumps are the heart and mainspring of the fluid power system in the Warner-Swasey Hopto excavator. Mounted on one common shaft, they deliver from a single drive the power which helps to make the Hopto one of the fastest, most powerful hydraulically operated excavators in the world.

Each of the three direct-mounted tandem pumps supplies the power for one of the three separate oil hydraulic systems. This assures full power on every action. Separate drives for each pump are eliminated. Installation of the tandem pump is clean. All three pumps take up little more space than one single pump. Savings in installation costs are obvious. And, when an extra power reserve is needed in one of the hydraulic systems, by simple valving the output of more than one pump can be combined. The Hopto takes full advantage of the COMMERCIAL tandem pump features. The three hydraulic systems work like this.

Power Used Independently—at a pump speed of 1800 rpm and relief valve pressure setting at 1500 psi—involves pump delivery of 40 gpm, 30 gpm and 30 gpm respectively into three pressurized circuits. Circuit number one powers the 360° swing of the Hopto and operates its dipper stick. Both the boom and bucket are powered by the second circuit. The third circuit delivers power for the Hopto's stabilizers.

Extra Power Requirements needed for excavating in hard ground are no problem. Power from the pump on the stabilizer circuit is tapped and combined with that of the dipper stick's pump. This power reserve enables the Hopto to dig where other machines fail.

A 20-ton push on the dipper stick is thus generated without the need for an oversized pump or the waste of prime mover horsepower.

Precision Tool Control at all times is a sure result with fluid power transmission. Just one example—no other kind of power transmission could provide such sensitive down-pressure on the tool. Varied operations like digging, swinging, lifting and loading are fast and accurate when oil hydraulics is the power transmitting media. Such multi-functional operations always respond to the precise command of the operator with a minimum of effort on his part.

Fluid power transmission, in contrast with mechanical power transmission, involves fewer wearing parts. It is free of elements which cause vibration. Combined with the outstanding performance of COMMERCIAL pumps, fluid power transmission makes possible the kind of lower maintenance, reduced down-time, and lower operating cost advantages Warner-Swasey offers in its Hopto.

We'll Cooperate Fully with you in designing your fluid power system—pumps, valves, motors, cylinders. Send details of your problem to Commercial Shearing & Stamping Company, Dept. A-14, Youngstown, Ohio.

COMMERCIAL
shearing and stamping

CLOSE-COUPLED PUMP-MOTOR

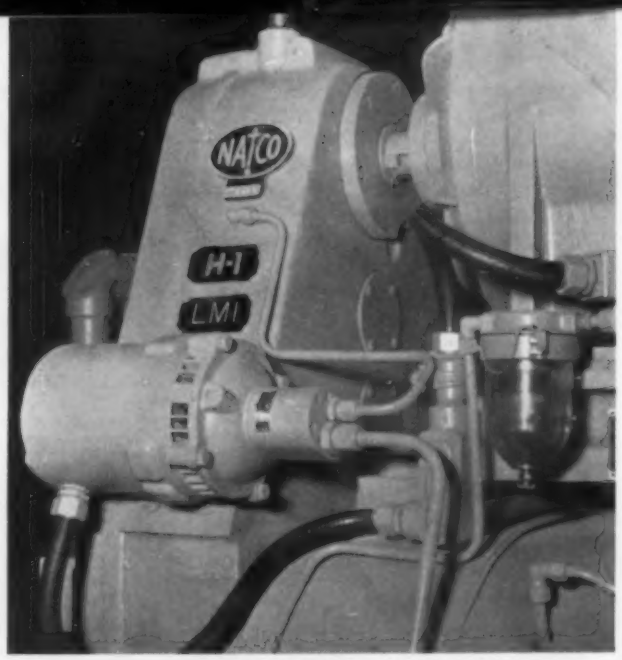
members. When the close-coupled unit is used, the motor end-bracket supports the pump, and a slight distortion of the top is not important.

• **Coupling Is Part of Motor**—The cost of a shaft coupling usually depends on its bore size, rather than its torque capacity. Since standard electric motors are designed with large shafts for belt drives, the hydraulic designer must select an oversize coupling. On early models in this development, the motor shaft diameters were reduced to match pump shaft diameters. On the new units, the coupling is supplied as part of the electric motor.

Usually the shaft height of the foot-mounted pump and its driving motor are not equal. To mount the pump and motor in the conventional arrangement, a mounting pad must be fabricated for the pump. The close-coupled unit eliminates this. A coupling guard is also eliminated. This guard usually requires drilling and tapping at least four additional holes in the top plate.

• **Lower Labor Cost**—Even in shops with skilled workmen, precise alignment may take as much as 2 or 3 man-hours. Close-coupled units can be aligned in minutes with very little skill. Not only is this a saving in cost and time, but it eliminates poor alignment which shortens pump life and frequently results in air leakage at the pump seal.

The power unit piping is often simplified with the close-coupled pump-motor. The area directly below the pump, is normally occupied by the pump



Courtesy Eastern Industries, Inc.

GEAR PUMP is mounted to totally enclosed motor on a machine for drilling railroad axles. Mounting bracket of pump has been designed so that it can be close-coupled to any motor with NEMA C face mounting. This gives flexibility in replacing motor.

feet, can be used for fittings and working room. Generally, the pump can be rotated on the motor mounting bracket, allowing the suction pipe to be dropped straight from the pump into the reservoir. Hydraulic pump manufacturers supply almost every

Continued on page 98

How do you shrink a motor to fit it and two hydraulic pumps into a machine space originally designed for the motor and only one pump?

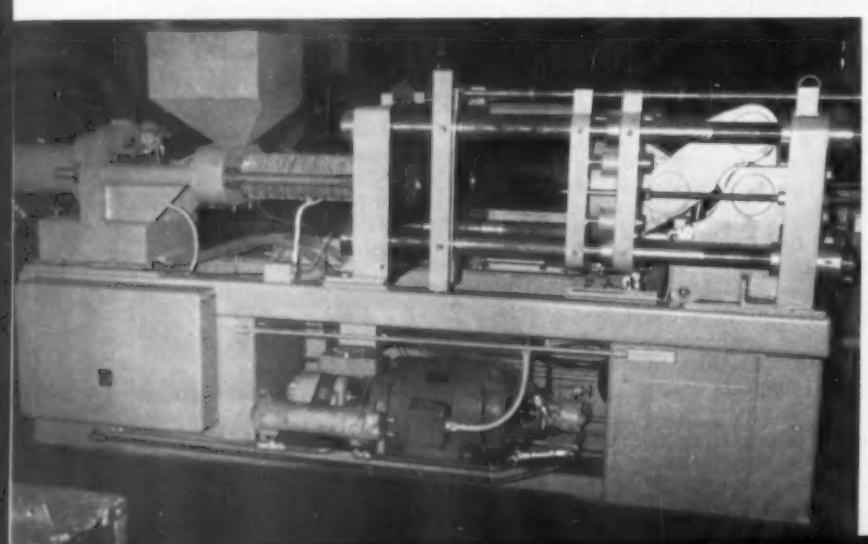
When The Lewis Welding & Engineering Corp. in Cleveland recently redesigned its injection molding machines, it had to install a new, two-pump hydraulic power source in the space originally provided for a single pump assembly.

The machines had a standard, 25-hp, squirrel-cage, induction motor as the prime mover, with one hydraulic pump separately foot-mounted and coupled to the motor. To improve the system, it was necessary to change the hydraulic system using two pumps. But keeping the standard dimensions ruled out using a standard motor or foot-mounted pumps. A non-standard motor would increase costs and delivery time.

Reliance Electric and Engineering Co. was requested to make complete laboratory tests of actual peak loads and operation cycles, to determine if a smaller motor could be used. However, the tests confirmed that the 25-hp motor was required, and a smaller motor would be overloaded.

Reliance did suggest a change to Class B insulation instead of the Class A material used in the previous motors. Such a change to higher temperature insulation then permitted using a smaller frame size motor for the same horsepower required by the application.

A standard Frame 326-U motor was selected to replace the larger Frame 404. Outfitted with Type C end-brackets, and special mounting brackets for close-coupling the hydraulic pumps on each end, the new motor-pump assembly fits snugly into the redesigned machine.



TIGHT SPACE on this redesigned die caster was a problem when two pumps had to be installed instead of one. Higher rated insulation in the motor, and flange mounting the pumps solved it.

PROOF
OF EXTRA
SAFETY...

ONLY GREER ACCUMULATORS MEET ALL SAFETY CODES!

Qualify for any type hydraulic installation under all safety ordinances everywhere because . . . they're

BURST-PROOF!

Design engineers using hydraulic accumulators on machines and equipment in interstate commerce must be aware of stringent nation-wide safety regulations. For guaranteed acceptance everywhere, specify the Greer Accumulator — the only accumulator that meets all safety codes. More than 81,000 Greer Accumulators are now in use in every state of the union and in almost every industry. These exclusive built in safety features tell you why:

AIR VALVE Absolutely leak-proof for pressures up to 12,000 psi. Integrally molded one-piece valve stem prevents gas loss.

SHELL No seams. No welds. No joints. Made of single-piece homogenous chrome molybdenum steel. 18% elongation in two inches guarantees against metal fatigue. 5 to 1 safety margin above maximum working pressure of the accumulator.

MOUTH Designed to yield at 400% of maximum working pressure. This safety feature releases pressure if relief valve clogs or sticks, or if system is blocked.

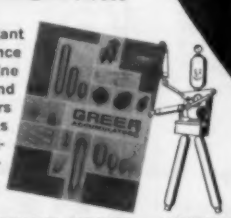
PLUG ASSEMBLY Accumulator cannot be disassembled until complete gas charge in bag has been released. Lack of this safety feature has caused serious accidents. Be sure to check this protection.

Greer Accumulators meet all J.I.C. and I.C.C. safety standards including the strict Penn. Boiler code, and conform with all municipal, state and insurance underwriters safety codes in accordance with ASME specifications on unfired pressure vessels.

Learn more about Greer Accumulators and how they can cut costs on your hydraulic equipment. Contact the franchised Greer distributor in Buffalo, Cleveland, Houston, Philadelphia and Pittsburgh. Inquiries invited from distributors in other areas.

WRITE OR PHONE FOR GREER BULLETIN PR-200

An important catalog reference on the complete line of Greer standard and special accumulators with circuit diagrams and applications. Also details on hydraulic components made by Greer such as valves, filters, actuators, etc.



U. S. PATENTS
UNDER
OLAER LICENSES

GREER HYDRAULICS INC. • INTERNATIONAL AIRPORT • JAMAICA 30, NEW YORK

Manufacturers of Precision Test Equipment and Hydraulic Components

DESIGN ENGINEERS...

need a small valve

on

- GAS AND LIQUID ANALYSIS EQUIPMENT
- INSTRUMENT AIR LINES
- LABORATORY TEST EQUIPMENT
- PILOT PLANT INSTALLATIONS
- GRAPHIC PANEL BOARDS
- HYDRAULIC AND PNEUMATIC EQUIPMENT
- AIRCRAFT AND AUTOMOTIVE TEST STANDS

for high pressure service

270 SERIES BAR STOCK NEEDLE VALVES

...5000 psi service. Made of brass, carbon steel, type 430F or 316 SS, or a combination carbon and 430F SS for high temperature service. Designed for throttling and shut-off of water, oil, gas or corrosive fluids. Features leak-tight O-ring stem seal. Can be panel mounted, too. Sizes ⅛" through ½".

or reverse flow check

570 SERIES CHECK VALVES

Feature extremely effective leak-tight seal, exceptional flow characteristics and low-cost. Synthetic rubber seats and stainless steel springs give maximum corrosion resistance. Available in brass or 303 SS in ball and piston types for 5000 psi service in sizes ⅛" through ½".

Why buy big when you can buy small

WRITE FOR CATALOG MV-057

HOKE

HOKE INCORPORATED
FLUID CONTROL SPECIALISTS
187 South Dean Street
Englewood, New Jersey

CIRCLE 66 ON READER SERVICE CARD

CLOSE-COUPLED PUMP-MOTOR

type of pump in this style at a lower cost than the identical foot-mounted pump.

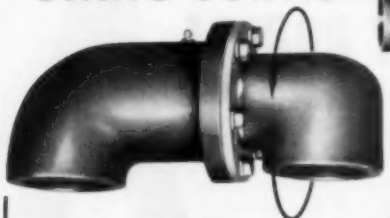
• **Why Not Sooner?**—There are two reasons. First, the widely varied mountings supplied by the hydraulic pump manufacturers. This together with rather limited market, discouraged the electric motor manufacturers from a development similar to their long established motors for water pumps. With the development of the splined coupling arrangement, the production problem of accommodating various pump designs has been overcome.

The second reason which has slowed development of the pump-motor is the idea of quick motor replacement. For this reason many hydraulic designers have stayed with standard motors. The error in this reasoning is that the average motor lasts much longer than the pump which it drives. When the pump is reinstalled after servicing, its subsequent life is frequently reduced by careless alignment. This work is very often done in the field by men who do not understand the importance of perfect alignment.

The polyphase electric motor is undoubtedly one of the most rugged and dependable machines in industry. To illustrate confidence of manufacturers in their reliability, in the machine tool industry, which is one of the largest users of industrial electric motors, most manufacturers build special motors into their machines. ▼▼▼

BARCO "Controlled Torque"

SWING JOINTS



for Loading and Unloading Lines

Built to support piping and provide swing movement in handling gasoline, oil, LP Gas, alcohol, and other fluids. Ball bearing, long sleeve design with "controlled torque" action permits uniform, easy movement, prevents annoying uncontrolled swinging. Single swing, double swing, and counterbalance styles to meet every need. In steel and malleable iron, sizes 1", 1¼", 2", 2½", 3", 4", 6" and 10". Also in complete loading line assemblies made to customer's specifications.

11 DIFFERENT STYLES—Special O-Ring seal insures leakproof service over wide temperature range, −40°F to +250°F.

INFORMATION—Send for latest Catalog No. 400 and engineering information. BARCO MANUFACTURING CO., 532E Hough Street, Barrington, Illinois.

CIRCLE 18 ON READER SERVICE CARD

The common denominator at IPC . . . is "CUSTOM"

Custom design + Custom tooling + Custom manufacture . . . IPC Oil Seals, in synthetic rubber or leather, are specifically designed to solve a particular sealing application.

Eliminate costly production delays and product failure by specifying IPC oil seals at the design stage. Our engineering staff will carefully check all conditions of your application before recommending an IPC Oil Seal or packings for you. IPC's "custom" oil seals and packings insure longer effective service under the most extreme conditions of pressure, temperature, abrasion and speed.

Contact your IPC representative or call us today.

PACKINGS / OIL SEALS / PRECISION MOLDING

BONDED BY IPC

1. Bonded Washer Seal Double Lip Wiper
3. Bonded Washer Seal Straight Lip
5. Bonded Washer Seal Straight Lip With Garter Spring
7. Bonded Case Seal Straight Lip
9. Bonded Case Seal Straight Lip With Garter Spring
11. Bonded Case Seal Straight Lip Thin Rind Type
13. Rubber Covered Bonded Case Seal Straight Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
2. Bonded Case Seal Double Lip Wiper
4. Bonded Washer Seal Limited Contact Lip
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
8. Bonded Case Seal Limited Contact Lip
10. Bonded Case Seal Limited Contact Lip With Garter Spring
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
14. Rubber Covered Bonded Case Seal Limited Contact Lip
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

INTERNATIONAL PACKINGS CORPORATION
Bristol, New Hampshire P2

CIRCLE 74 ON READER SERVICE CARD

Comparing pump power requirements

• By Sanford Ellis, *George M. Pearse & Co., Newark, N. J.*

Here's a study of how much power it takes to supply a press using three different pump arrangements. Initial cost, service life, and pressure rating are other factors in selecting the best pump for the job.

TO DETERMINE power requirements for a typical machine tool feed consisting of rapid advance, compression, return, and idle, it is helpful to draw curves of horsepower vs time for various types of pumps.

The area under the curve for each sequence of the cycle is proportional to energy required, since energy is a function of power and time. Cost of operation is directly proportional to the total energy consumed during the complete cycle.

Calculations from these curves are based on the formulas:

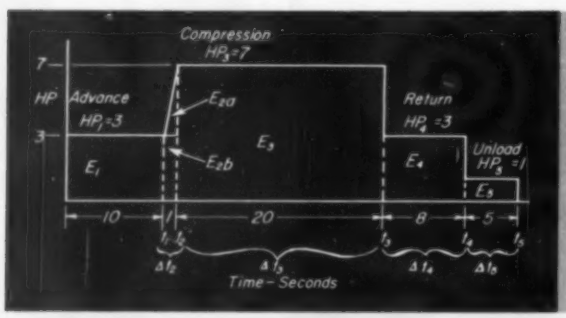
$$HP = K \times P \times V \quad \text{.....(1)}$$

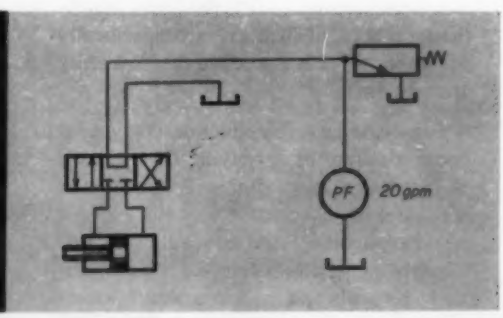
$$E = HP \times t \quad \text{.....(2)}$$

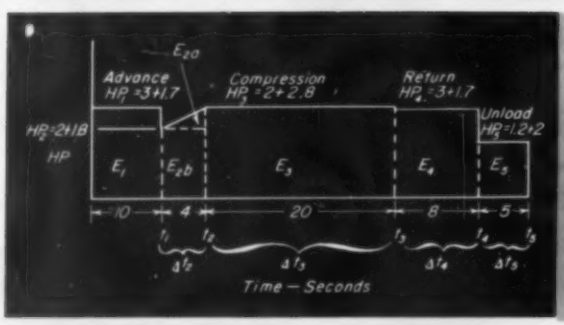
$$E_{total} = \Sigma E_1 + E_2 + E_3 + E_4 + E_5 \quad \text{.....(3)}$$

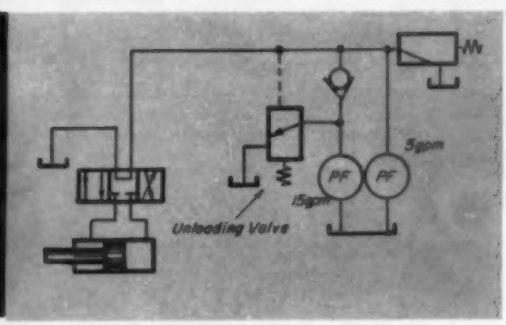
Where:

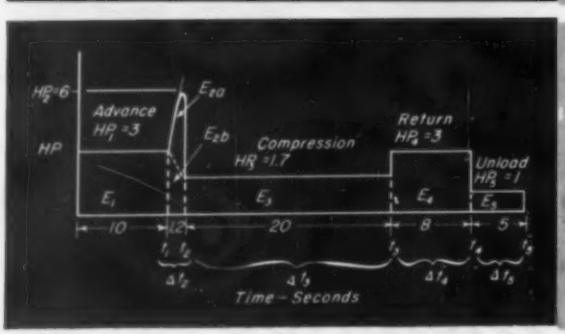
HP = Horsepower
K = Constant for changing units
t = Time
E = Energy
P = Pressure
V = Volume

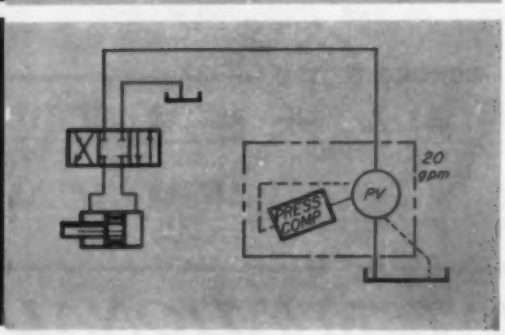








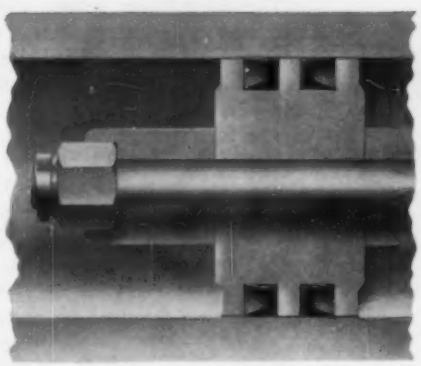




NEW FLARED-LIP U-CUP PACKING REDUCES FRICTION

Garlock's new homogeneous U-cups are designed for minimum frictional resistance in low pressure air or hydraulic cylinder applications. They are molded of synthetic rubber with flared sidewalls which also facilitate assembly, especially when cylinder bores vary slightly in size. Instantaneous sealing after sudden pressure changes is another advantage of the flared-lip design. Sizes ½" O.D. to 3¾" O.D. are available from stock. Sizes to meet all AN6226 and JIC dimensional specifications.

Homogeneous U-cups are another part of the famous "Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only complete line . . . it's another reason you get unbiased recommendations from your Garlock representative. Call him or write for AD163.



The new Garlock 9511 U-cup Packing is recommended for pressures to 2000 psi. The flared-lip design creates an interference fit especially adaptable to applications involving sudden pressure changes. Clearance at the heel reduces friction, makes assembly easier.

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Plastic Products, Molded and Extruded Rubber

CIRCLE 50 ON READER SERVICE CARD

COMPARING PUMP POWER REQUIREMENTS

In the curves for a fixed displacement pump, hi-lo combination, and pressure compensated pump, E_1 is the energy required to advance the load. Although sufficient pressure is required to overcome static inertia, this is usually relatively low and pump volume is the deciding factor in energy requirement.

The value of E_2 is energy used in performing the actual work stroke. This may be divided into two parts: E_{2a} is that part which performs useful work; E_{2b} is that part which is wasted. If the actuator met solid resistance after rapid advance, area E_2 would become zero, because horsepower required for advance would increase instantly to that required for static compression. This neglects compression time of the fluid.

The most critical area is E_3. This represents nearly all the heat put into the system. If E_3 cannot be kept small, a heat exchanger may be required.

Area E_4 for the return sequence is affected by speed requirements similar to E_1. Area E_5 represents energy consumed by the unloaded system. Even though pressure is dropped to near zero during this phase, as with an unloading system, E_5 will probably have an appreciable magnitude.

Assigning values to the press sequence, assume that 20 gpm at 200 psi is required to advance the platen in 10 seconds and retract it in 8 seconds. Pressure for compressing the work is 500 psi. Compressing the material takes 1 second and the 500 psi pressure must be maintained for 20 seconds.

The horsepower values shown on the curves and used in the calculations are all based on *input* horsepower data supplied by the pump manufacturers. Therefore, the factors of slip, friction, and efficiency are included.

The following calculations are to obtain relative values of energy which can be converted to units of ft-lb by using the factor of 33,000 ft-lb/min per hp. Time in seconds is converted to minutes.

Computing energy required by a fixed displacement pump during compression:

$$E_3 = HP_2 \times \Delta t_2$$

The power required for compression is 7 hp so:

$$E_3 = 7 \times \frac{20}{60} = 2.33$$

For a hi-lo combination of 15-gpm and 5-gpm pumps, the value of HP_3 for the high volume pump unloaded at 0 psi is 2.8 hp, and for the low volume pump it is 2 hp. Then:

$$E_3 = \frac{20}{60}(2 + 2.8) = 1.6$$

For a 20-gpm pressure-compensated, vane pump requiring 1.7 hp at 500 psi:

$$E_3 = \frac{20}{60} \times 1.7 = .57$$

The useful work (E_{2a}) performed during a compressive stroke is the same for all types of pumps and has no value for comparison. In this example, $E_{2a} = .033$ for all three cases. The energy wasted (E_{2b}) varies considerably and is a direct indication of pump efficiency.

Calculating the energy wasted during the one-second compressive movement, for the fixed displacement pump:

$$E_{2b} = HP_1 \Delta t_2 = 3 \times \frac{1}{60} = .05$$

For the hi-lo combination:

$$E_{2b} = (2 + 1.8) \times \frac{4}{60} = .25$$

For the pressure-compensated pump:

$$E_{2b} = \tfrac{1}{2}(HP_1 - HP_2)\,\Delta t_2 + HP_2\,\Delta t_2$$

$$= \tfrac{1}{2}(3 - 1.7)\frac{1.2}{60} + 1.7 \times \frac{1.2}{60} = .047$$

The conventional method of determining motor size is based on the equation:

$$HP_{RMS} = \sqrt{\frac{HP_1^2 t_1 + HP_2^2 \Delta t_2 + HP_3^2 \Delta t_3 \ldots}{t_1 + \Delta t_2 + \Delta t_3 \ldots + \Delta t_n / C}} \quad (4)$$

The value of C is taken as 2 for enclosed motors and 3 for open motors.

Equation (4) can also be written:

$$HP_{RMS} = \sqrt{\frac{E_1^2/t_1 + E_2^2/\Delta t_2 + E_3^2/\Delta t_3 \ldots}{t_1 + \Delta t_2 + \Delta t_3 \ldots + \Delta t_n / C}} \quad (5)$$

Energy values during each phase of the cycle for the fixed displacement pump are:

$E_1 = .50$ $E_2 = .083$ $E_3 = 2.33$ $E_4 = .40$ $E_5 = .083$

Using equation (5):

$$HP_{RMS} = 5.15 \text{ hp}$$

With a service factor of 1.15, it would be safe to specify a 5-hp motor.

Energy values for the hi-lo combination are:

$E_1 = .78$ $E_2 = .28$ $E_3 = 1.6$ $E_4 = .62$ $E_5 = .26$

Using equation (5)

$$HP_{RMS} = 4.10 \text{ hp}$$

This would require a 5-hp motor.

Energy values for a pressure compensated pump are:

$E_1 = .50$ $E_2 = .080$ $E_3 = .57$ $E_4 = .40$ $E_5 = .083$

Substituting in equation (5):

$$HP_{RMS} = 2.35$$

A 3-hp motor can be used. This will have a maximum overload of 100% for 1.2 sec during the compressive stroke. By specifying a *softer* acting governor control, a 2-hp motor could be used. Pump delivery would then decrease more in proportion to pressure increase. Peak power during the compressive stroke would then be 4 hp or less. Furthermore Δt_2 would be increased. Both these factors would decrease the required horsepower.

Although all three circuits are shown with 3-position directional valves, the pressure-compensated pump circuit can use a 2-position valve. This would allow the pump to *dead-head* during idle time so that HP_5 would equal HP_3. Since deadhead horsepower (HP_3) is 1.7:

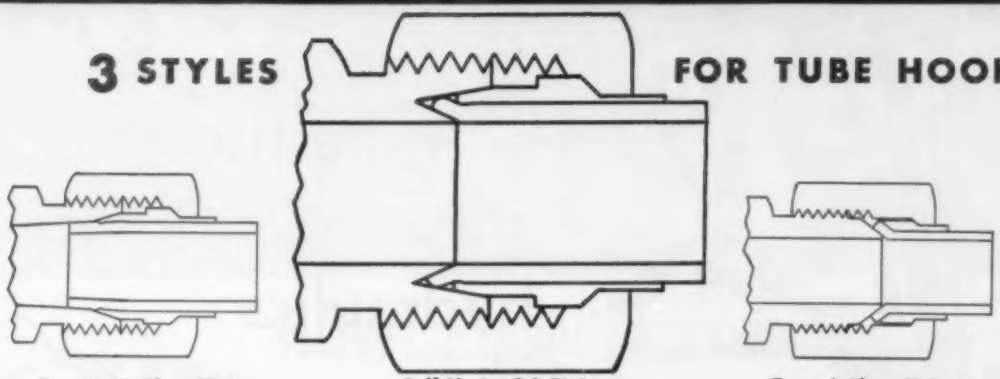
$$E_5 \text{ (deadhead)} = 1.7 \times \frac{5}{60} = .141$$

▼▼▼

FLODAR HYDRAULIC FITTINGS

High and Low Pressure — for Every Job and Rating

3 STYLES FOR TUBE HOOKUP



Type B No-Flare Fitting

Special construction creates safe, sure seal without threading, soldering, welding or flaring. Three-point tube support with alloy sleeve absorbs vibration, gives better sealing action. All popular shapes and sizes.

Self-Flaring BA Fitting

Unique construction absorbs vibration and permits use of thin-wall tubing. Eliminates flaring, welding, threading and soldering. Flare is made when nut is tightened. Capacity to 20,000 psi and more. All standard shapes and sizes.

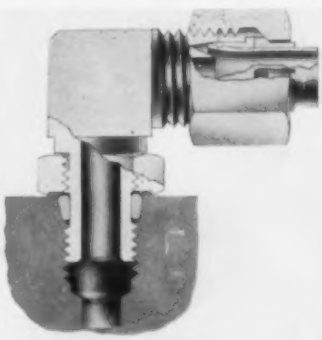
Type A Flare Fitting

Popular three-piece fitting, using heat-treated alloy sleeve. Designed to meet higher fluid pressures where excessive vibration from fluid shocks must be dampened or absorbed. J.I.C. hydraulic standard, AN dimensions. Outstanding performance.

Metal-to-Metal Seal

Flodar's newest Port Hole fitting with straight threads. Cuts time and labor costs. Eliminates precision machining. Permits multiple installation of tees and elbows in cramped space. Coins own seat on step as nut is tightened, eliminating necessity of an O-Ring. Positive sealing under all conditions. Standard shapes and sizes.

Flodar Fittings are available in Steel, Brass, Stainless Steel and Aluminum for assemblies using steel, copper, stainless steel, aluminum, vinyl, plastic and polyethylene tubing.



O-Ring Fittings

Specially designed for use with hydraulic fluids. Fits all S.A.E. portholes. Available in AN large hex. Can be had in all conventional shapes and sizes.

Standard Pipe Fittings

Flodar makes a complete line of high-pressure Steel Pipe Fittings in all sizes and shapes. Made from steel bar stock to J.I.C. and S.A.E. standards, with dry seal, precision threads.

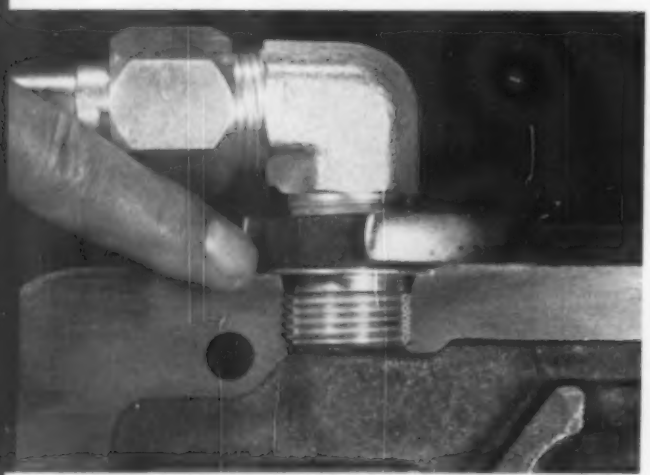
STOCKS IN ALL PRINCIPAL CITIES

WRITE FOR OUR NEW, ILLUSTRATED CATALOGS

FLODAR CORPORATION

Cleveland 10, Ohio

BIG LOADS, moving fast demand more power. This fork truck uses a 2000-psi circuit.



Courtesy Parker-Hannifin Corp.

NEW fittings help make high pressure systems successful.

Take the easy step to 2000-psi hydraulics

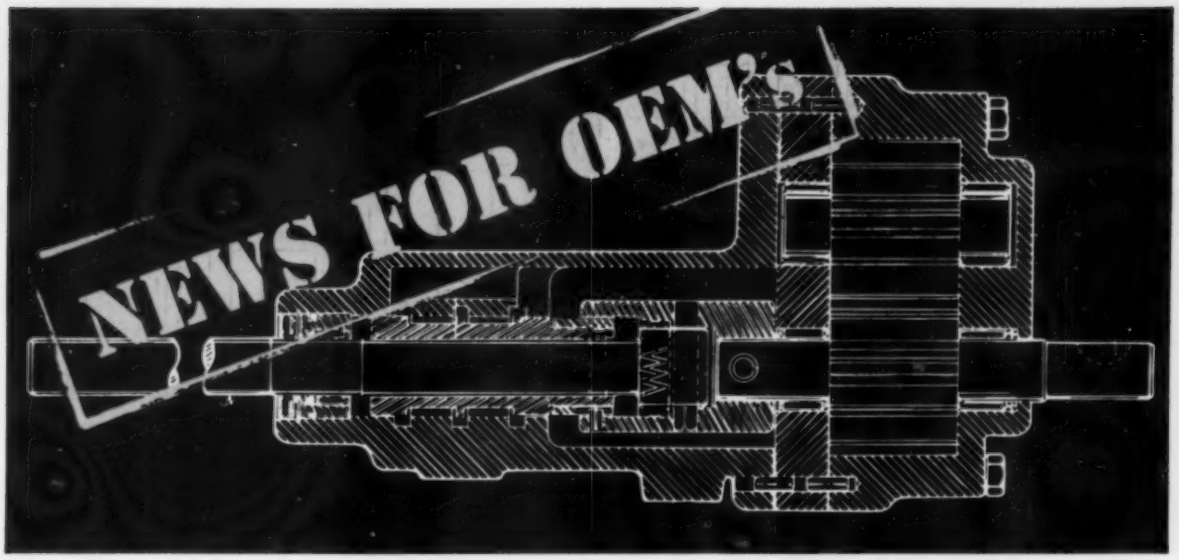
DO DESIGNERS want more powerful hydraulic drives? They do on mobile equipment where more work in a smaller package helps sell machines. In recent years gear and vane type pumps have been developed which make possible 2000-psi systems that will cost no more than 1000-psi systems. Taking the step to 2000 psi is easy. Going even higher is practical, and it is being done; but it takes special study.* Almost all the industrial trucks and construction equipment makers now have equipment with higher power hydraulics.

• **It's faster**—Clark Equipment Company is now using 2000 psi on a line of its lift trucks to get greater lifting speeds. It means more loads can get on and off the truck forks. Clark was able to reduce the lift cylinder from 4 to 3 inches I.D., giving the operator greater visibility.

• **Standard components**—Except for the cylinder, which Clark designed, all the components were designed and supplied by hydraulic equipment manufacturers. Size is the big factor. Every fork truck manufacturer tries to keep truck dimensions small so that it can turn on a dime. The Clarklift was built to work in aisles six inches narrower than the old model could work in. Smaller cylinder and higher pressure kept component sizes down. With less oil required, the sump was made 5% smaller. To avoid the leaks that often go with higher pressures, Clark switched from pipe threaded connections to straight-threads and O-ring seals.

With a higher pressure system, better filtration to get longer pump life was needed. A 10-micron filter was installed on the suction side of the pump. ▼▼▼

* See 6000 *psi system—What does it offer?* APPLIED HYDRAULICS, December 1957, page 78



Behlen

NOW! *Expanded production makes* HYDRAULIC SERVO MECHANISM

available to MORE original equipment manufacturers

Originally known as the Behlen Powr-Steer, this advanced rotary type hydraulic servo mechanism has proved highly successful on thousands of farm tractors of many models and makes. Behlen was first to offer power steering for row crop tractors, five years ago. For the past two years, Powr-Steer has been used on a leading farm tractor line as original equipment. Demand soon outstripped our production capacity.

Now Behlen production facilities have been expanded to the point where we can offer our Hydraulic Servo Mechanism to a wide field of manufacturers of industrial heavy construction and agricultural equipment. From tractors to earth-movers. From fork-lift trucks to power shovels — every type of equipment where manual labor needs to be reduced.

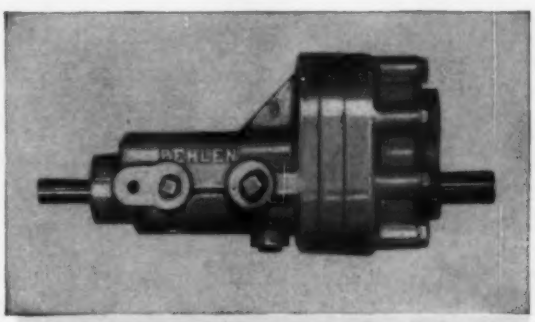
In supplying the hydraulic "muscle" of Behlen's servo mechanism to your product, you will add magic to its sales appeal.

We invite you to see how easily the Behlen Hydraulic Servo Mechanism can be applied to your products as original equipment (or as extra equipment readily installed in the field). Your request (which will not obligate you in any way) will receive the personal attention of our production manager, Howard Christenson.

Phone, write or wire

BEHLEN MANUFACTURING COMPANY
Dept. AH-4 Columbus, Nebraska

World's largest manufacturer of tractor and grader power steering



The Behlen Hydraulic Servo Mechanism, Rotary Type, Series 2000, can be used for power steering or wherever a rotary servo motion is required. Controller and actuating parts are in one compact unit, for economy and simple installation.

FULL 360° OPERATION

The Behlen unit is a gear-type hydraulic mechanism (in contrast to the piston type on passenger cars and other equipment). The power source in the unit is a gear motor that will provide continuous 360° turning under full power in either direction.

The power unit is mounted anywhere along the steering shaft. While the Powr-Steer operates as a servo mechanism between steering source and wheels, it also blocks and controls wheel shocks. Does not affect steering ratio. Maintains full and positive control through mechanical linkage in event of hydraulic power failure.

Specialized engineers in our Hydraulic Division are ready to adapt Powr-Steer to your specific needs in any of hundreds of machinery and equipment applications.

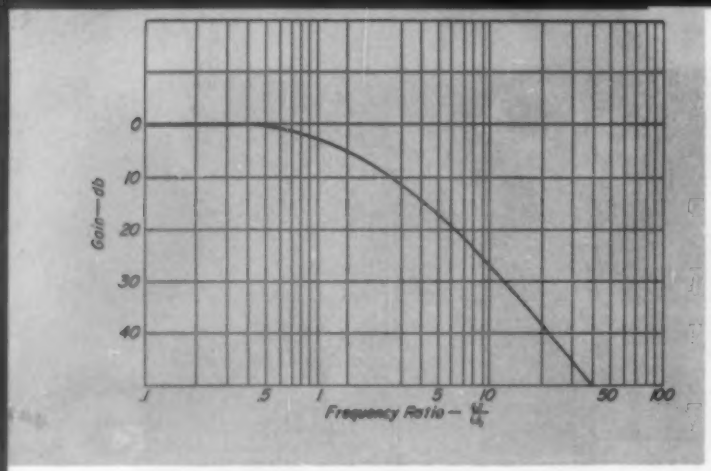


FIG. 1. TYPICAL FREQUENCY RESPONSE curve of a hydraulic servomotor.

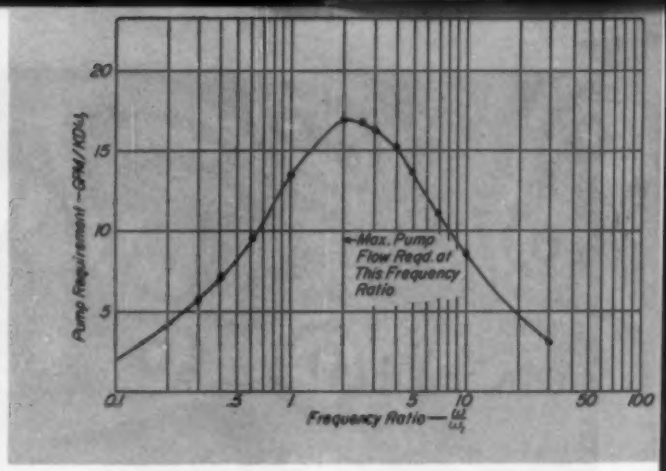


FIG. 2. GENERALIZED PUMP REQUIREMENT for a hydraulic servomotor.

Matching pumps to frequency response

• By Paul E. Straight, *Electronic Engineer, Hagan Chemicals & Controls, Inc., Pittsburgh, Pa.*

In selecting a pump for a servo system, there is a peak flow demand depending on frequency of the output actuator. The pump must be sized for this, or an accumulator can supply the peak demand.

LIKE all hydraulic actuators, a hydraulic servomotor using position feedback requires a supply of oil under pressure. The pressure generator must have an output equal to, or greater than, the maximum required rate of oil flow through the servomotor. With an actuating cylinder, feeding a machine table at a given rate, the required rate of oil delivery is the maximum table speed times the piston area. With a servomotor positioning a machine table, the calculation of oil delivery rate is more complex.

The output speed of a servomotor varies with the input signal and with the instantaneous position error. The input signal depends on the characteristics of the system. Position error depends on the input signal and the response of the servomotor.

• **Frequency Response**—The desired response of the servomotor and the nature of the input signals are determined by an analysis that involves the dynamic requirements of the complete system. This analysis often gives the requirements of the servomotor in terms that control engineers call *frequency response*. The servomotor is designed to give this response with a given oil pressure. Finally, a pump capacity is chosen for the maximum oil consumption of the servomotor, as calculated from a frequency response curve.

• **Oil Consumption and Frequency**—A typical frequency response curve of a hydraulic servomotor is shown in Figure 1. The curve is in the form that is generally used by control engineers. The ratio of output amplitude to input amplitude in decibels (db) is plotted against the ratio of the frequency to a characteristic frequency of the servomotor.

The flow of oil that corresponds to the output piston speed is the pump requirement. This can be expressed as:

$$gpm = 120\ ADf \qquad (1)$$

where A = peak to peak output amplitude, inches

$$D = \frac{\text{effective area of piston, sq. in.}}{231\ \omega\ \text{in./gal}}$$

f = frequency, cycles/second

Equation 1 can be expressed in terms of a characteristic frequency of the servomotor by means of the following substitutions:

Let ω_1 = characteristic frequency, radians/second

ω = frequency, radians/second

CIRCLE 3 →

AFCO

37° FLARED "J.I.C." and FLARELESS TUBE • PIPE and HOSE

FITTINGS

STEEL • ALUMINUM ALLOY • BRASS • STAINLESS STEEL

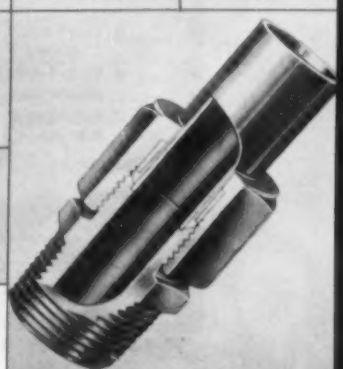
37° FLARED "J.I.C."

FLARED TUBE FITTINGS and PIPE FITTINGS

J 815 TUBE UNION	J 815-X-X REDUCER UNION				
J 816 MALE CONNECTOR	J 854 FEMALE CONNECTOR	J 821 TUBE ELBOW	J 822 MALE ELBOW	J 877 LONG MALE ELBOW	J 878 EXTRA LONG MALE ELBOW
J 823 MALE ELBOW 45°	J 855 FEMALE ELBOW	J 824 TUBE TEE	J 825 MALE SIDE TEE	J 826 MALE RUN TEE	J 856 FEMALE SIDE TEE
J 857 FEMALE RUN TEE	J 827 TUBE CROSS	J 832 BULKHEAD UNION	J 833 BULKHEAD ELBOW	J 834 BULKHEAD TEE	J 837 45° BULKHEAD ELBOW	J 806 TUBE PLUG—FLARED	J 860 TUBE END REDUCER
J 818 TUBE NUT	J 819 TUBE SLEEVE	J 820 TUBE CAP—FLARED	J 924 BULKHEAD LOCKNUT	910 PIPE CONNECTOR	911 PIPE NIPPLE	912 REDUCING BUSHING	913 SQUARE HEAD PLUG
914 90° STREET ELBOW	915 45° STREET ELBOW	916 PIPE ELBOW	917 PIPE TEE	918 PIPE CROSS	932 HOLLOW HEX PLUG	933 HEX HEAD PLUG	840 HOSE NIPPLE

FLARELESS TUBE FITTINGS

				F 815 TUBE UNION	F 815-X-X TUBE UNION REDUCER	842 90° HOSE ELBOW	844 45° HOSE ELBOW
F 816 MALE CONNECTOR	F 854 FEMALE CONNECTOR	F 821 TUBE UNION ELBOW	F 822 90° MALE ELBOW	F 823 45° MALE ELBOW	F 855 FEMALE ELBOW	F 824 TUBE TEE	F 825 MALE SIDE TEE
F 826 MALE RUN TEE	F 856 FEMALE SIDE TEE	F 857 FEMALE RUN TEE	F 827 TUBE CROSS	F 832 BULKHEAD UNION	F 833 90° BULKHEAD ELBOW		
F 834 BULKHEAD TEE	F 837 45° BULKHEAD ELBOW	F 860 TUBE END REDUCER	F 818 TUBE NUT	F 819 TUBE SLEEVE	F 924 BULKHEAD LOCKNUT		
F 929 TUBE CAP	F 806 TUBE PLUG						



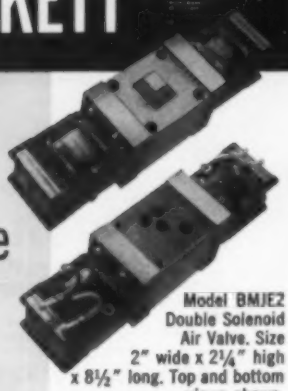
FLARELESS

AFCO FITTING CO.

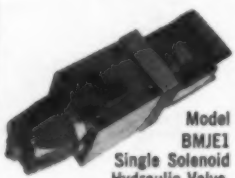
5300 Harvard Avenue Cleveland 5, Ohio

SEND FOR CATALOG ON THE COMPLETE LINE OF — AFCO INDUSTRIAL FITTINGS

IT'S NEW
from BECKETT
Small size high performance air and hydraulic valves for manifold mounting
(Note Valve Sizes)

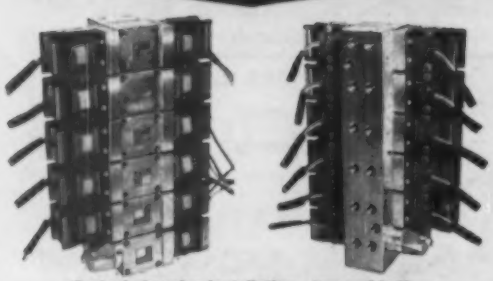


Model BMJE2 Double Solenoid Air Valve. Size 2" wide x 2¼" high x 8½" long. Top and bottom views shown.



Model BMJE1 Single Solenoid Hydraulic Valve. Size 2" wide x 2¼" high x 7¼" long.

Provide extremely compact multiple valve installation with common subplate for automation controls on specialized machine tools and other production equipment.



Typical six valve installation—top and bottom views shown. Block is 12½" long.

- Valves mount on 2" centers.
- Up to 6 units on one manifold.
- Two, three or four way.
- All spool types available.
- Special spools to specifications.
- Solenoid, pilot or manual control.
- Nominal ¼" size

WRITE now for full details on this latest Beckett Hi-Cyclic Valve development. Check with Beckett on all of your directional control valve requirements.

DISTRIBUTORS IN MAJOR CITIES COAST-TO-COAST

THE BECKETT-HARCUM COMPANY
1086 WAYNE ROAD, WILMINGTON, OHIO

MATCHING PUMPS

Frequency in radians/second is related to frequency in cycles per second by the following equation: -

$$f = \frac{\omega}{2\pi} \quad \text{.....(2)}$$

Multiplying and dividing by ω_1 gives

$$f = \frac{\omega_1}{2\pi}\left(\frac{\omega}{\omega_1}\right) \quad \text{.....(3)}$$

Thus

$$\text{gpm} = \left(\frac{120}{2\pi} AD\omega_1\right)\left(\frac{\omega}{\omega_1}\right) \quad \text{.....(4)}$$

To apply equation (4), the output amplitude A has to be evaluated from Figure 1. The values of gain in decibels can be converted to values of amplitude ratio to determine the actual amplitude A. The gain in decibels is:

$$\text{gain} = 20 \log \frac{A}{K} \quad \text{.....(5)}$$

where K = peak to peak input amplitude, in.

Thus

$$\frac{A}{K} = \text{antilog} \frac{\text{gain}}{20} \quad \text{.....(6)}$$

From Figure 1 and equation (6), values of A/K can be obtained for values of W/W_1. By inserting these values of A/K in equation (4), the generalized variation of pump requirement with frequency ratio is obtained. Figure 2 is a plot of this variation for the response given in Figure 1. Figure 2 shows that the peak demand is at $W/W_1 = 2.0$.

• **Calculation of pump size**—To illustrate, assume:

ω_1 = 10 radians/second
Input amplitude = 1 inch (peak to peak)
Effective piston area = 10 square inches
Frequency response as given in Figure 1

From Figure 2, the maximum demand is at $\frac{\omega}{\omega_1} = 2.0$

where the value of the term $\frac{\text{gpm}}{KD}$ is approximately 17.

$$\text{gpm} = 17 \times 1 \times \frac{10}{231} \times 10 = 7.4$$

The value of pump capacity, determined by this method is that required to maintain the desired frequency response. ▼▼▼

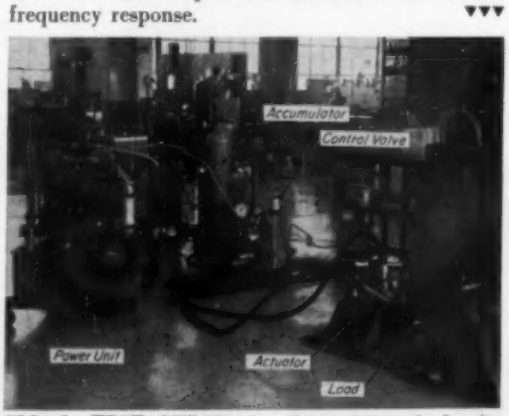
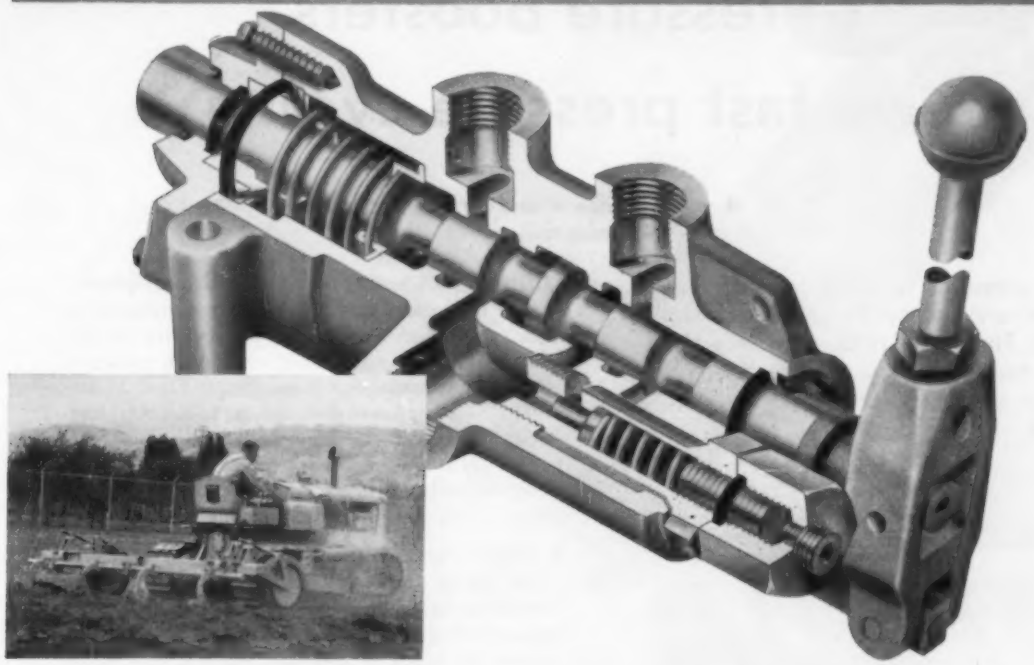


FIG. 3. TEST SET-UP for determining hydraulic servo motor frequency response.

NATIONAL OIL SEAL LOGBOOK



Use of O-rings as moving seal in heavy duty bulldozer control valve

1,500 psi variation without backup rings. Intermittent operation plus long periods of inactivity. Extreme external dust and dirt conditions. Irregular and unpredictable field servicing. Fluid oil temperatures reaching 180°F. Climatic temperature extremes from —30° to +120°F. Life expectancy is required to be that of the tractor.

Above are the rugged operating conditions faced and met by National industrial O-rings in the new Be-Ge Model SU-1200F bulldozer blade control valve. A total of four rings are employed in each unit; two in a moving shaft application and two as static seals.

Be-Ge reports no leakage or ring failure on hundreds of heavy duty applications involving Oliver, Caterpillar, International Harvester and other crawler tractor installations.

National offers a complete line of industrial O-rings, plus many exclusive compounds. Special compounding is also available to meet unusual conditions.

For complete information on National O-Rings, or for skilled O-ring engineering service, call your nearest National Seal engineer. In major cities nationwide. See the Yellow Pages, under "Oil Seals".

Syntech® Oil Seals

Syntech oil seals, developed by and offered exclusively by National, are widely used synthetic rubber seals for applications where temperatures reach 250°F, speeds reach 3,600 FPM, and total indicator runout is as high as .030. Basic 50,000 series Syntech (illustrated) employs a tough, accurately manufactured steel outer case, precision-tensioned spring and accurately molded and trimmed Syntech sealing lip.

Micro-Torc Oil Seals

Micro-torc oil seals, pioneered by National, are sturdy, dependable leather seals. Special elastomer coating on *surface* of chrome re-tanned leather sealing lip prevents seepage of oil. Yet inner body of sealing lip retains natural porosity to "store" lubricant against accidental periods of starvation. Inherent lubricity of elastomer coating produces a lower torque, longer lasting, economical oil seal. Available in a wide variety of types and sizes.

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

4624

CIRCLE 96 ON READER SERVICE CARD

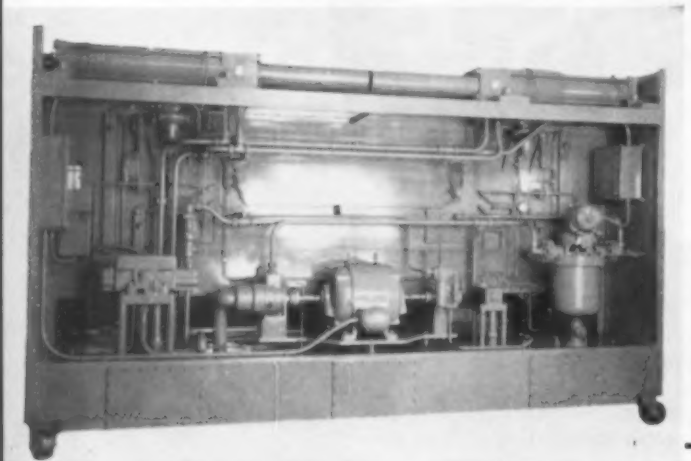
2-Pressure boosters give fast pressure cycling

• By Rex C. Burnham and W. F. Dickinson
J. N. Fauver Co., Detroit, Michigan

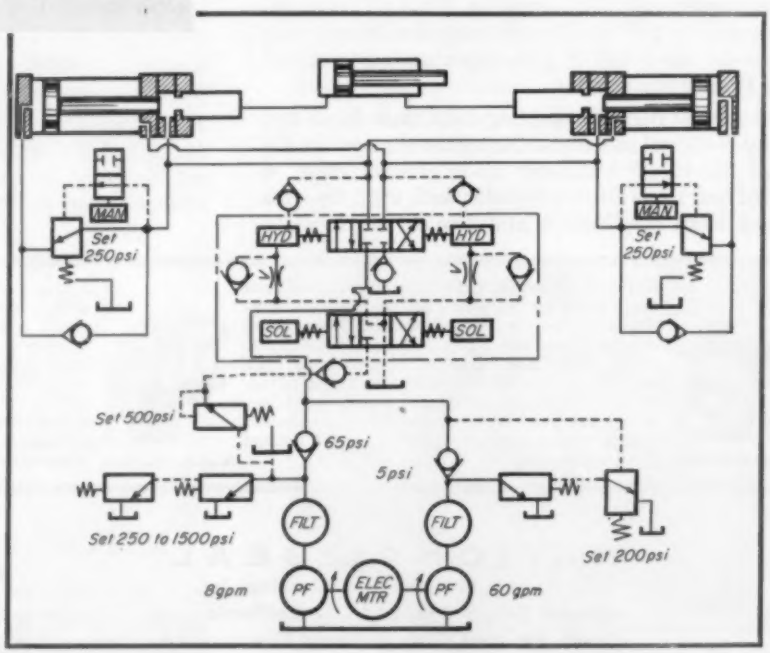
Where pressures to 7500 psi are needed, boosters are usually the most economical method. The single stroke boosters on this cycling tester give low pressure filling from the hi-lo source before applying boosted pressure.

HIGH pressure testing requires flexible equipment. For high speed and low power requirements it must supply high flow at low pressure for filling, and then almost no flow at very high pressure when the test component is completely filled. Miller Fluid Power engineers designed the hi-lo tester, and the J. N. Fauver Co. built it. Two single stroke boosters give the final high pressure. High pressure is not applied until the cylinder under test is completely filled. This speeds the testing.

• **Pump Arrangement**—One 60-gpm and one 8-gpm pump are installed in a hi-lo system. The large capacity pump is unloaded at 200 psi set on the unloading valve. Venting the relief valve increases the speed of response, since a very small movement of the unloading valve spool will vent the relief valve. The small capacity pump delivers through a 65-psi check valve to provide pilot pressure for the directional valve. A vented relief valve connected to the small volume pump outlet line is



REAR OF TESTER shows boosters mounted at top. Nominal 5:1 boosters have 7-inch bores and 3-inch rams. Stroke of each is 30 inches. Each pump has high pressure filter. Filter for 60-gpm pump has motorized cleaning attachment.



BOOSTER DESIGN and use of sequence valves permit fast filling of test cylinder before boosted pressure is applied. As many as 9 cylinders can be cycled at once.

Why the Leader gives you more!

Because of his laboratories and know-how the leader can give you better design. The leader can afford more efficient tooling and greater quality control.

The leader can give you a better cylinder without a premium price.

The leader in air and hydraulic cylinders is Hannifin.

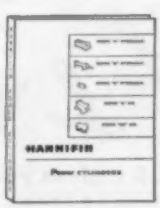
AIR AND HYDRAULIC

HANNIFIN

POWER CYLINDERS

Write for your copy of this new Hannifin Cylinder File —complete, easy-to-use, easy-to-order-from information on five lines of Hannifin cylinders. Hannifin Company, 545 South Wolf Road, Des Plaines, Illinois.

(Hannifin Company is a division of Parker-Hannifin Corporation.)



CIRCLE 61 ON READER SERVICE CARD

New Products By

L and L

Only L & L offers the complete line of fittings, with the widest choice of design, for any type of hydraulic piping application.

CN Fittings

- L & L "CN" seals pressure *without* use of O-Ring.
- Savings in tools, scrap and loss of production, also in assembly and maintenance.
- Eliminates stress in valves—elbows and tees can be positioned to 405°.
- Assemble and reassemble without damage to port or fitting—no need for sealing compounds.
- Excellent resistance to vibration.

L & L O-Ring Fitting

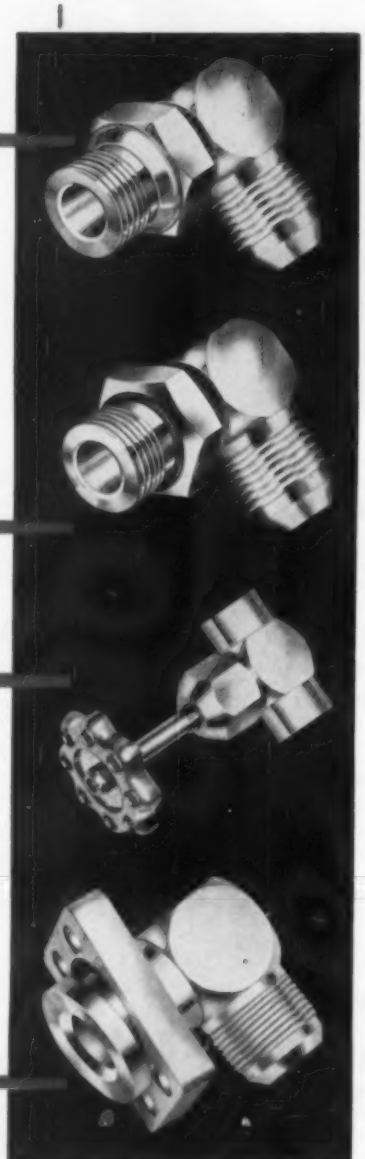
- Seals pressure *with* O-Ring.
- Reduces installation time—no need for sealing compounds.
- Range of sizes from ⅛" to 2".

Metering Valves
Carbon and Stainless Steel

- Pressures up to 5000 PSI.
- Straight or angle valves with male pipe, female pipe or tube connections.
- Use as a metering or shut-off valve.
- Range of sizes from ⅛" to ¾".

Flange Fittings

- S.A.E. bolt hole spacing.
- Solid and swivel tube, pipe or weld connections.
- O-Ring seal.
- Elbows and tees can be positioned.
- Bolt together and use as flange unions.



Representatives in principal cities. Write for full particulars to:

L and L MANUFACTURING COMPANY
8088 E. Nine Mile Rd., Van Dyke, Mich.

Only L & L gives you a "Complete Fitting Line"
See the L & L Exhibit, Design Engineering Show, Booth 438

2 PRESSURE BOOSTERS

regulated by a remote control on the tester panel. This can be set for pump pressures from 250 to 1500 psi to give final test pressures of 1250 to 7500 psi from the 5:1 booster.

- **Sequencing**—This is the test cycle:

a. Extending the test cylinder
b. Applying high pressure
c. Decompressing
d. Retracting the cylinder
e. Applying high pressure
f. Decompressing.

Timing of this cycle is controlled by a synchronous motor timer which actuates the solenoids of the 4-way directional control valve. Pilot oil to operate this valve is supplied through a pressure reducing valve set at 500 psi.

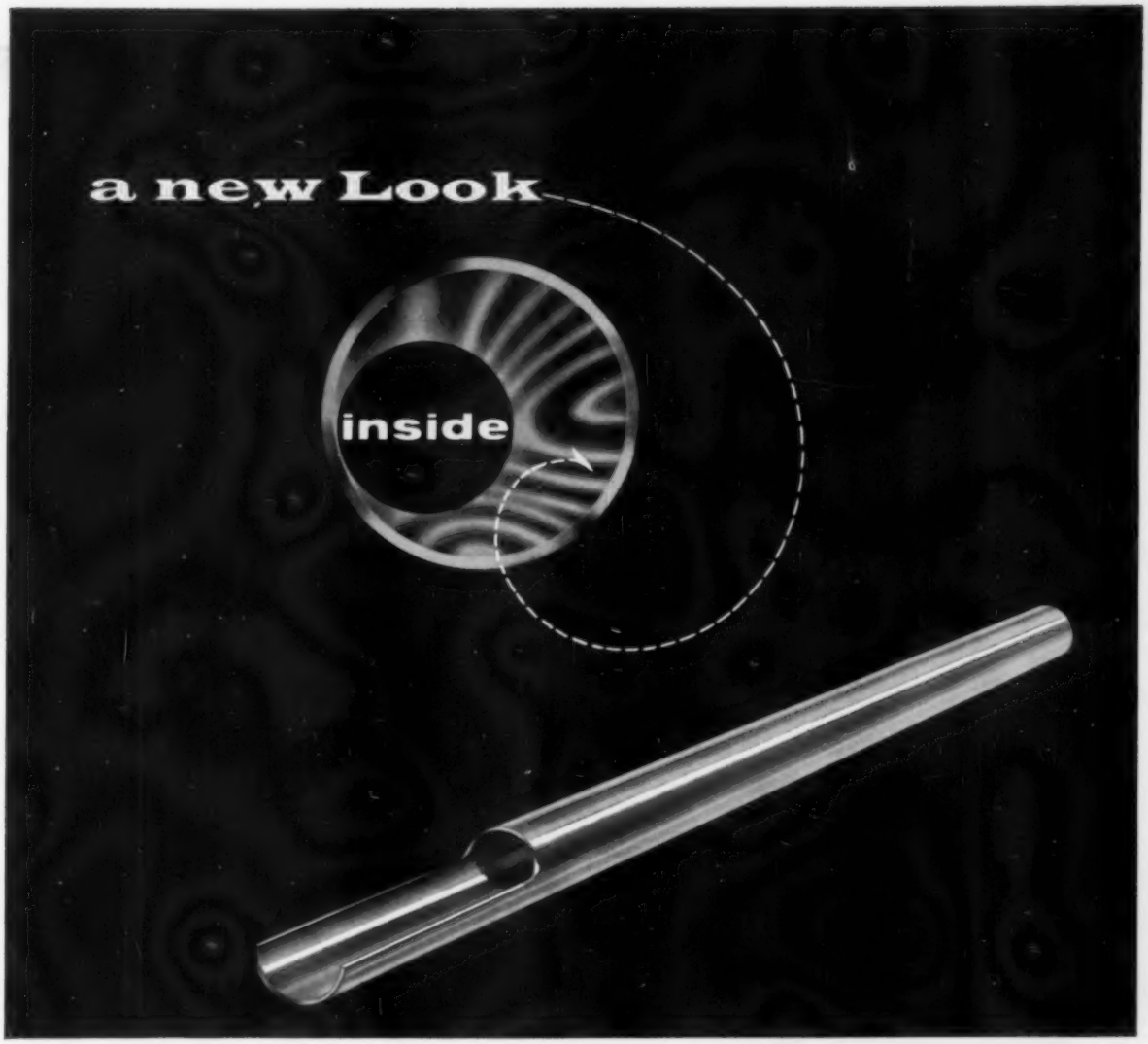
- **Decompression**—As the pilot spool of the directional valve shifts through neutral, the pressure line from the valve to the booster is connected to tank through the pilot operators and chokes, and this line is decompressed. The pilot spool continues to shift to its extreme position and apply pressure to the pilot operator of the main spool. However, the main spool does not shift immediately because of the decompressing pressure in the pilot operator opposite the one being actuated. When this decompressing pressure falls below the pilot pressure, the main valve shifts. Thus the reducing valve can be set for the required decompressed pressure. The pilot choke orifices govern the speed of decompression.

The check valve in the pilot line prevents flow from the booster lines through the pilot operators and back through the pilot spool when system pressure rises above the setting of the pressure reducing valve. Such a flow could flood the reducing valve drain.

High pressure fluid in the booster and test cylinder decompresses as the booster cylinder is retracted.

- **2-Pressure Boosters**—The boosters are constructed so that the test cylinder is extended or retracted by the 60-gpm pump. At the end of the cylinder stroke, pressure rises, and the 8-gpm pump supplies fluid for actuating and holding the boosters. Pump-pressure fluid is then applied through the sequence valve to the cap end of the booster to move the ram forward. The booster ram closes off the line from the directional valve and applies boosted pressure to the test cylinder. The boosters are connected so that they are alternately retracted as the test cylinder is reciprocated.

Manually operated, 2-way valves are connected in the pilot lines of the sequence valves. Closing these valves takes the boosters out of the system, so the test cylinder can be reciprocated at a pressure limited by the relief valve. ▼▼▼



LUSTRALOY—the first and only standard production stainless tube with a premium I. D. finish

Look down a Lustraloy tube and you'll say, "Premium finish"!
And you're right, based on all past standards. But this is Lustraloy
with a *production* finish . . . *selling at standard stainless tube prices.*
Lustraloy is mandrel-drawn to cold work both inside and outside tube surfaces;
finished by bright annealing. The result is tubing with uniform roundness,
consistent wall thicknesses, mirror finishes and the finest flow characteristics.
If you require seamless, stainless tubing (⅜" to ¼" O.D.)
with emphasis on I.D. finish, Lustraloy is important to you.
The attached coupon will return samples and technical information.

Summerill
STAINLESS TUBE DIVISION
COLUMBIA STEEL & SHAFTING CO.
Pittsburgh 30, Pa.

Summerill Stainless Tube Division, Dept. AH-2
Columbia Steel and Shafting Co., Pittsburgh 30, Pa.
Please send sample and technical information on LUSTRALOY.

Name_____
Co._____ Title_____
Street_____
City_____ State_____

CIRCLE 32 ON READER SERVICE CARD

Using minimum delivery and minimum efficiency limits, curves can be plotted to establish ranges of pump delivery for a fast production check of pump and electric motor combinations.

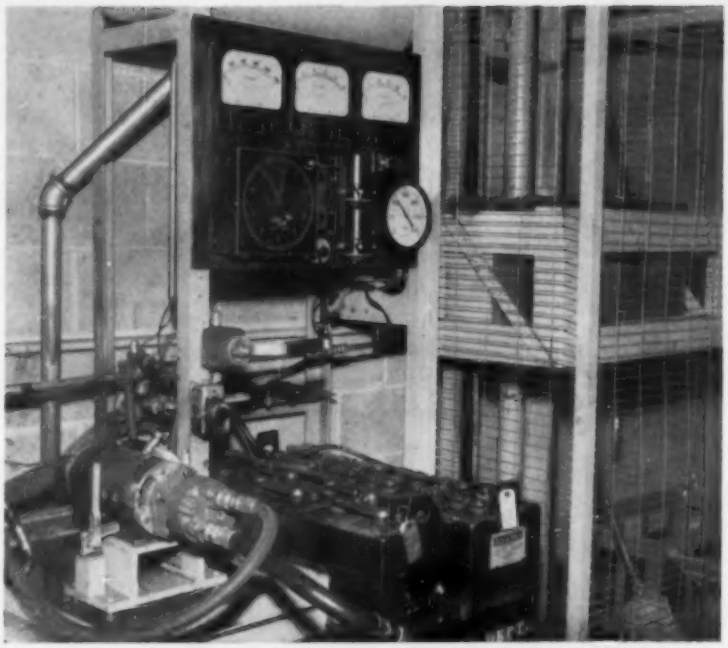


FIG. 1. PRODUCTION testing uses a simple bench test with a single-acting cylinder operating at 1200 psi. Limit switches trip an electric timer when a known volume of oil is displaced to indicate pump volume.

How to test low voltage motor-pumps

• By G. F. Young

Manager, General Engineering, Raymond Corp., Green, N. Y.

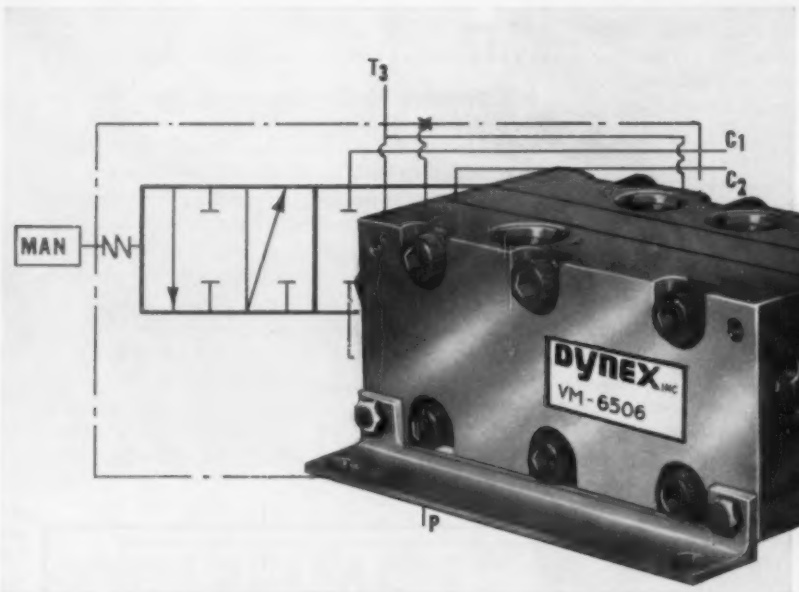
VARIATIONS in applications of pumps on industrial trucks are practically limitless. Coupling this with the wide range of duty cycles which the trucks may be required to perform presents an economic question of how many types of hydraulic power units should be offered. From a manufacturing cost standpoint it is advantageous to keep the number of variations low. From the customer's standpoint, the unit should be matched perfectly to his particular application. Also since the energy supply is a battery, and the hydraulic system will consume as much as 75% of this energy, it is important to maintain a maximum efficiency.

• **Pump volume**—We used a simple bench test, Figure 1, with a single-acting displacement cylinder, lifting a suitably sized load, developing an average pressure of 1200 psi. By installing limit switches to trip an electric timer after a known volume of oil had been displaced, we could easily check pump volume. A voltmeter and ammeter measured the power input. Pressure is measured at the pump outlet, thereby including the system losses as part of the load. This provides the necessary information to check the unit efficiency.

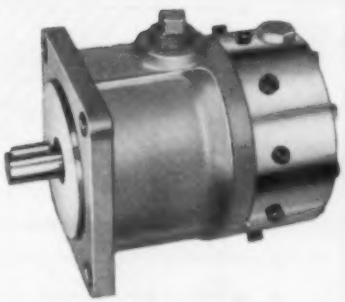
• **Delivery limits**—The next step was to establish limits for production standards. Random selection of stock pumps and motors, although indi-

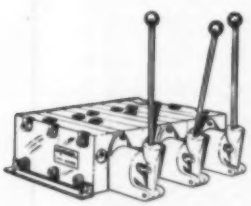
NEW...

6000 psi SLIDE PLATE DIRECTIONAL VALVE



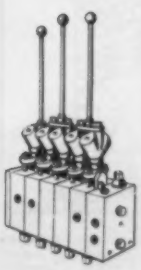
The VM-6506 valve series is the low cost answer to increases in pressure range on Industrial and Mobile hydraulic circuits. This multiple segment valve features a balanced sliding plate with excellent metering characteristics, averaging 5 times less internal leakage than comparable spool valves, while operating nominally to 6000 psi at 6 gpm. Integral relief valve, compact, easily banked, series-parallel circuit.





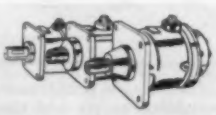
Newest in the Dynex line of power pumps. The PF-3021 embodies the latest design concepts in axial piston pumps. Split flow from 1 to 10 pistons — High Efficiency — Compact — 14 gpm at 1800 rpm and 3000 psi. Also available in 6000 psi version model PF-6015.

Dynex also manufactures a complete line of power pumps, handpumps, valves, cylinders and power packages.



Dynex® INC.

AN AFFILIATE OF **BLACKHAWK** MFG. CO.



777 DYNEX DRIVE, PEWAUKEE, WISCONSIN, DEPT. C581

CIRCLE 39 ON READER SERVICE CARD

vidually acceptable, would produce a wide range of results when bench tested. Two extremes could exist: high displacement, high current draw unit; and low displacement, low current draw unit. Both units could have the same combined pump and motor efficiency. With these units spotted and coded, we could give better customer satisfaction without carrying additional sizes of pumps and motors.

The only problem remaining was to establish limits which could be easily used in the production testing section. We know that two parameters exist which must be met: a certain minimum delivery; and a certain minimum efficiency. By using the equation:

$$\text{Eff} = \frac{\text{Hydraulic HP Output}}{\text{Electrical HP Input}} = \frac{\text{gpm x psi}}{\text{volts x amperes}}$$

it is possible to plot a family of curves for various current draws, of efficiency vs time; time being directly proportional to gpm, Figure 2. From this part of the curve we can establish three ranges of delivery for three types of applications. These ranges are governed by experience or knowing what elevating speeds are most desirable for various trucks. As noted on Figure 2, the production test operator simply color codes the unit with a dab of paint.

Advantages of Testing

A fast production check of pump and motor combinations. By simply reading current and time, the operator can accept or reject the unit, and if acceptable, code the unit, so it may be properly applied.

By coding the pump and motor combinations, advantage is taken of the normal spread of unit performance by using the high speed units in trucks requiring the speed, and grading from there.

• **Efficiency limit**—The second limit involves the minimum efficiency we can accept, and is shown by the heavy dashed line. This curve is determined by considering both electrical and heat limits. First, a single point is definitely located as the maximum allowable current density in the brush. Knowing this, and neglecting windage and friction, the energy lost from the energy supplied will develop heat, and at maximum brush current density we can assume this is the maximum allowable heat the unit can stand. This forms the minimum condition. Then by simply calculating this value of heat at maximum brush current condition and using it as a constant at other lower current conditions, the dashed curve can be developed for minimum efficiencies. ▼▼▼

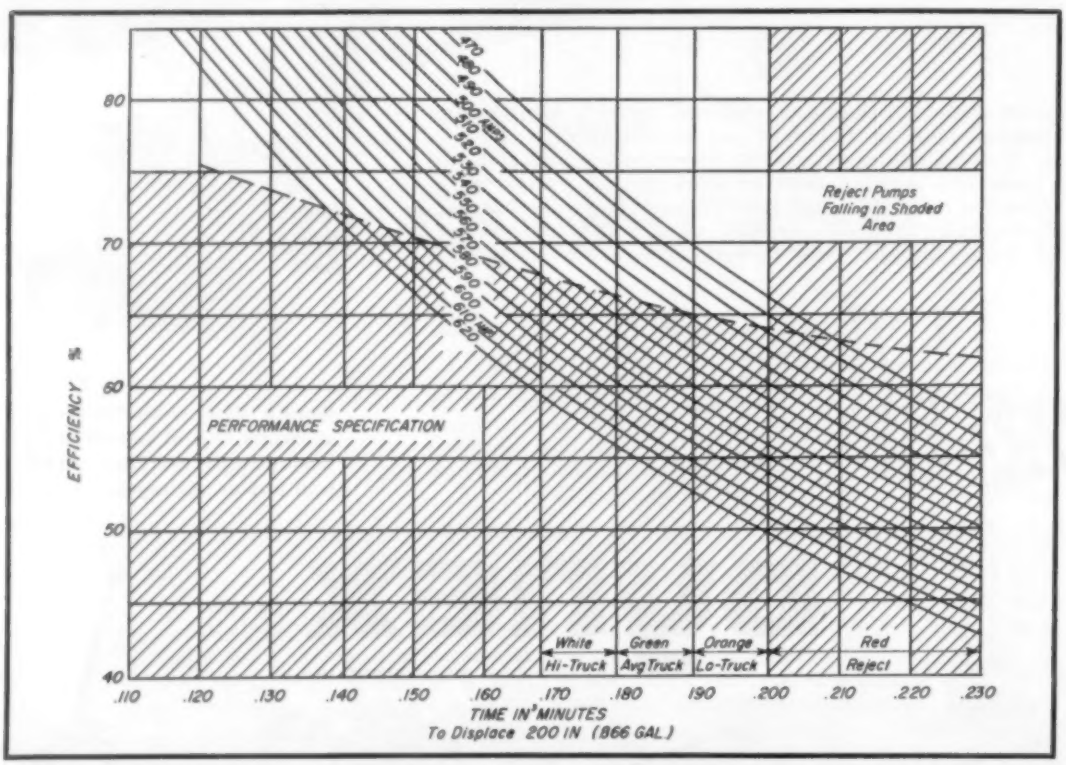


FIG. 2. PERFORMANCE chart shows minimum delivery and minimum efficiency acceptable for three requirements of truck speeds. By reading amps and time an operator can accept and code the unit, or reject it.

RIVETT SQUAREMASTER "100" CYLINDERS

Unfailing POWER for MILLIONS of cycles!

Here's sure power for unfailing cylinder operation. SQUAREMASTER 100's are the world's finest constructed cylinders—perform with 100% efficiency! 200 P.S.I. air to 500 P.S.I. oil. Available in 7 mountings with standard dimensions, in 10 bore diameters, internal and external threading. Special models and cover combinations. Priced competitively; prompt delivery; meet all J.I.C. requirements.

RIVETT, INCORPORATED

Dept. AH-4, Brighton 35, Boston, Mass.

*Initial High Coefficient of Static Friction

POWER-PACKED FEATURES PROTECTED BY POWER-GUARD CONSTRUCTION

1. Piston rod. Ground and polished alloy steel. Hard chrome-plated. **2.** Piston rod bearing. Replaceable cartridge-type. **3.** Piston packing adjusts automatically. V-block packing minimizes friction. **4.** Correctly stressed tie rods. **5.** Cushion bushings. Bronze, floating type. **6.** Ports rotated to any 90° position. **7.** Steel covers. Take minimum mounting space.

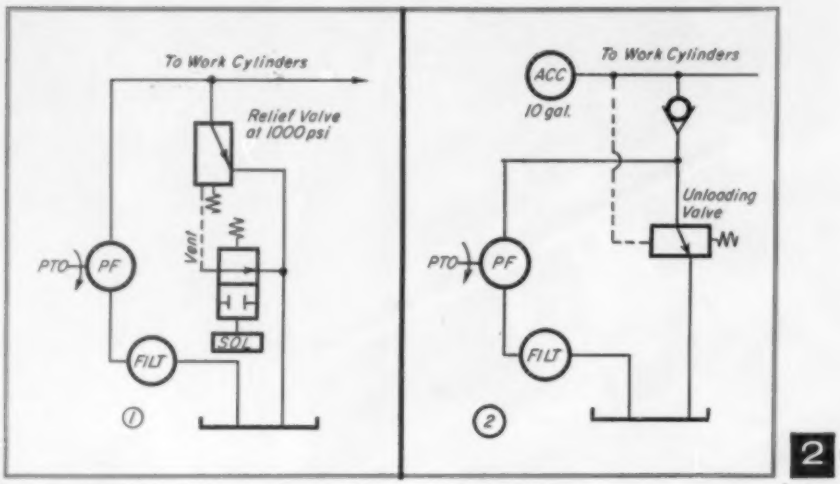
Send for catalog. Proof of SQUAREMASTER efficiency stated in these 20 pages. Write today.

RIVETT

furnishes a complete power package

AIR AND HYDRAULIC—VALVES, CYLINDERS, POWER UNITS

Member — National Fluid Power Association



1 **VENTED RELIEF** required operator action to unload the pump. Hydraulic power is lost when the truck engine stops.

2 **ACCUMULATOR** provides an emergency power source. Pump automatically unloads when accumulator is charged.

Accumulator gives fast response and low power

• By Lester Myers, *Chief Engineer, Mobile Aerial Towers, Inc. Fort Wayne, Ind.*

and Don Thomas
TEC Engineering Corp., Logansport, Ind.

AN OPERATOR in the crow's nest of an aerial tower has complete control of raising, lowering and rotating his position. All this while he completes a maintenance job 100 feet above the ground. With a single lever, he remotely controls two boom-positioning cylinders and a rotary torque actuator which permits up to 270 degrees rotation of the tower.

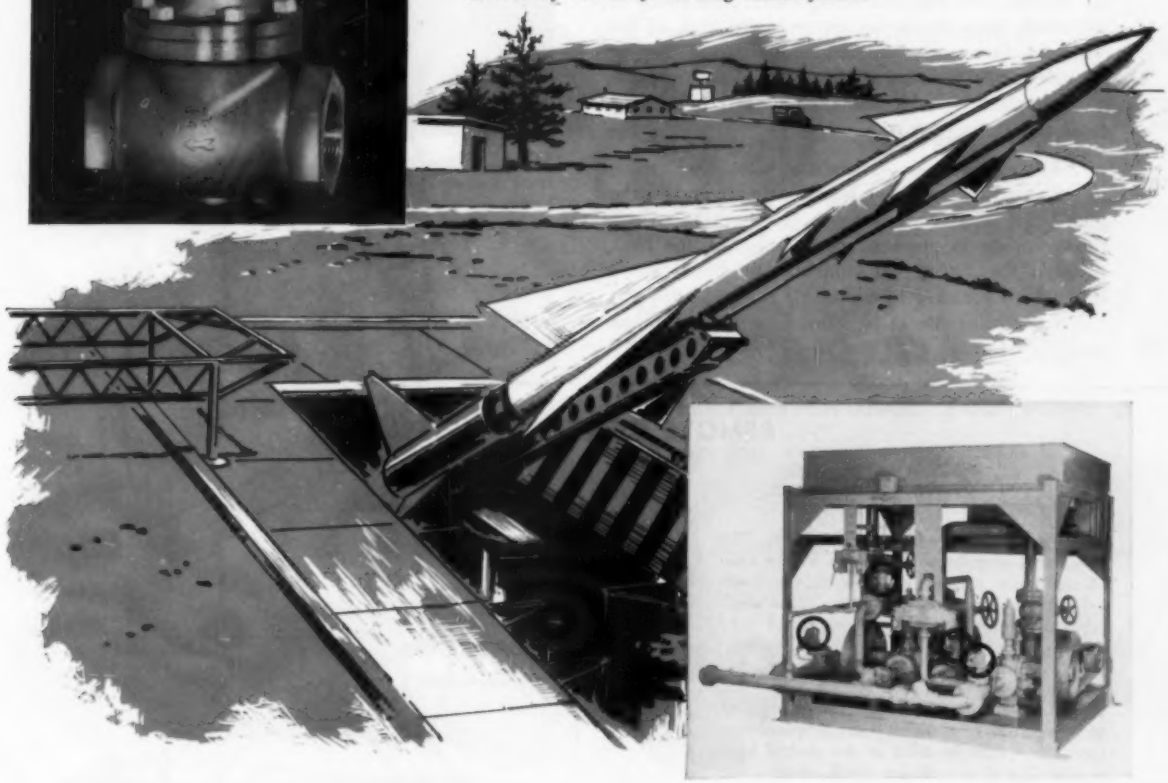
Power comes from a 1000-psi gear pump driven from a take-off on the truck engine. Three-position, closed-center, 4-way valves control speed and direction of all motions. The closed-center valves were used for smoothest control.

• **Unloading system**—In the development of the hydraulic system used on these towers, two pump unloading methods have been used. The simplest and least expensive has a pilot-operated relief having its vent connection piped to tank through a normally open, 2-position solenoid-operated valve. A foot switch up in the crow's nest is used by the operator to open and close this vent valve. Several short-comings show up with this circuit. First,

where dependability is vital . . .

ASCO solenoid valves help unleash Nike Missiles

Circling the industrial heartland of America, Nike anti-aircraft installations are designed to keep the production capacity of the country intact. Stored underground for protection, Nike launching platforms are raised hydraulically when alerted by the early warning radar system.



The complete stability and reliability of all launching and accessory equipment is vital. That is why Wayne Pump Company, designers and manufacturers of the hydraulic elevating system, have specified ASCO solenoid valves . . . no less than four are used on each pumping unit.

In military and civilian control applications alike, the comprehensive line of ASCO solenoid valves has demonstrated unexcelled dependability.

Special ASCO Bulletin 8210A solenoid valves with ASCO 3-way pilots permit gradual acceleration in raising and lowering of Nike elevator platform. ASCO packless valves specified in the Wayne Pump elevator system are typical of the more than 1300 different 2, 3, and 4-way solenoid valves supplied by ASCO wherever dependability and quality are vital.

Write for Catalog 201 covering complete line of ASCO solenoid valves

VISIT US AT THE DESIGN ENGINEERING SHOW BOOTHS 481, 483 & 485

Automatic Switch Co.

50-B Hanover Road, Florham Park, New Jersey

FRontier 7-4600

ASCO®

ACCUMULATOR GIVES FAST RESPONSE

the operator seldom remembers or cares to release the foot switch and unload the pump when he isn't moving the tower. Therefore, oil at maximum relief valve setting is pumped to tank, creating heat and lost power. Second, even if the operator properly uses the foot switch to load and unload the pump, there's a noticeable lag between closing the vent connection and building up pressure. Third, the moment the truck engine stops, the hydraulic system quits working too.

These drawbacks have been overcome by replacing the pilot-operated relief and vent valve with an accumulator and unloading valve. The pump is unloaded when the accumulator is charged. If the truck engine stops, the accumulator can supply enough power to lower the tower. The accumulator also supplies portable tools such as tree pruning tools and chain saws.

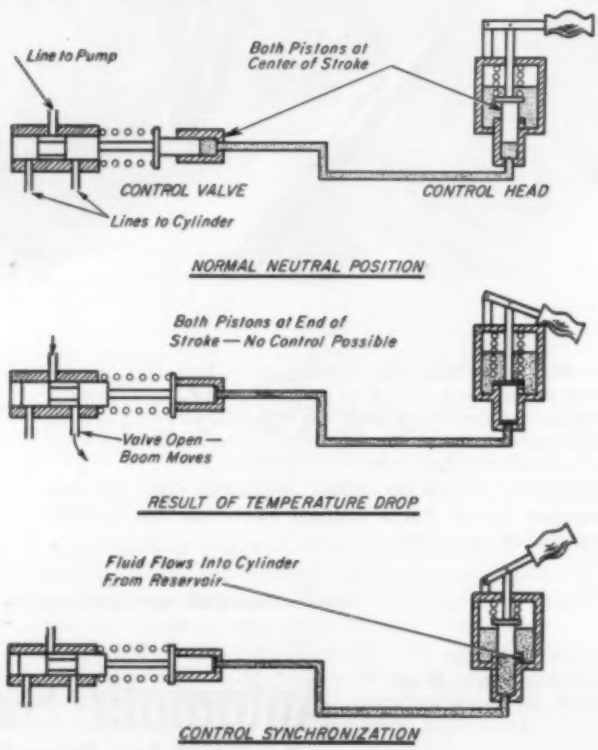
• **Safety features**—There's a pilot-check valve in each end of the lower boom cylinder and in the blank end of the upper boom cylinder. They lock the cylinders in place by preventing leakage back through the directional control. The boom won't lower until pressure builds up on the rod ends and opens the pilot checks to allow flow out the blank ends. ▼▼▼

SMALL diameter control lines carry oil from the crow's nest to the valve bank at the base of the tower.

REMOTE CONTROL SYSTEM

The control system has two main parts. The 3-section hydraulic control valve at the base of the boom controls oil flow to the boom cylinders and turntable actuator. Three small tubes connect the valves with a control head on the platform. The control head has a linkage for operating any of three pistons by a single handle. The lines between valve and control head are filled with fluid, which acts as a pushrod to transmit control movements from the master cylinder in the control head to a similar slave cylinder which actuates the control valve. Since the fluid can work only in compression, strong springs are placed behind master and slave pistons, allowing the slave pistons to duplicate all movements of the master piston.

In neutral, the spring pressures are balanced against the fluid column in the tube. Suppose a drop in temperature shrinks the fluid in the tube. The springs will force the pistons to the end of their stroke. Result: faulty boom motion. A rise in temperature would move the boom in the opposite direction. To correct this, the master and slave units must be synchronized. It's done by lifting the master pistons to the upper end of the stroke allowing oil flow in or out of the cylinder.

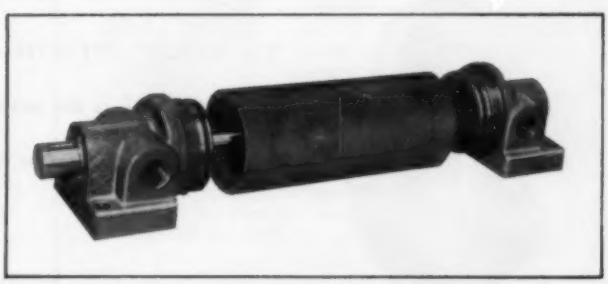

Line to Pump
Both Pistons at Center of Stroke
CONTROL VALVE
CONTROL HEAD
Lines to Cylinder
NORMAL NEUTRAL POSITION
Both Pistons at End of Stroke — No Control Possible
Valve Open — Boom Moves
RESULT OF TEMPERATURE DROP
Fluid Flows Into Cylinder From Reservoir
CONTROL SYNCHRONIZATION

BOSS . . . *PLEASE*
NEXT TIME BUY
PATHON CYLINDERS

Does your maintenance man need six arms? He won't if you specify

PATHON CYLINDERS

With* PATHON HYDRAULIC CYLINDERS *the maintenance you save may be your own.



Even the most durable equipment ultimately requires maintenance. When that time comes you continue to get extra advantages with Pathon Cylinders.

The rod packing is externally replaceable. When you disassemble the cylinder you do it so easily — *one piece at a time*. When you reassemble the piston in the barrel — no special tools, or collapsing devices are required.

With Pathon Cylinders you won't need a six armed maintenance man to reassemble an assortment of bolts, nuts, plates, mounting brackets, etc., and no more of this, "Joe, see if you can locate a torque wrench. We have to get this machine running."

Pathon

THE PATHON MANUFACTURING CO.
3823 Pacific Ave. Cincinnati 12, Ohio

The case for kcm pump ratings

• By R. W. Johns, A.P.I.A., *Johns Hydraulics Ltd., Melbourne E.I. Australia*

HERE'S what an Australian engineer suggests for international agreement on pump delivery ratings.

• **Gallon Standards**—Users of American pumps outside the United States often use a different kind of "gallon". In the U. S. A., the gallon has a 231 cubic inches; in Australia it has 278, and in countries using metric measure, they don't use gallon units at all. As a rating for pump delivery, gallons really aren't a convenient measure regardless of whose values you use. For every practical application you have to convert to a ram speed in inches per minute. That being so, why rate pumps in gpm?

• **A-C Frequency**—Our Australian 50-cycle current drives motors at 1000 and 1500 rpm instead of the 1200 and 1800 rpm 60-cycle current gives. The combined troubles of gallon standards and A-C frequency often involve us in a calculation like this:

$$\text{Pump output} = 6.6 \text{ U.S. gpm at } 1200 \text{ rpm}$$

$$\text{In Imperial gpm at 1000 rpm} = \frac{6.6 \times 231 \times 1000}{278 \times 1200} = 4.5$$

When we order a pump from the United States to deliver so many Imperial gpm and run on 50-cycle current we have this calculation:

$$\text{Requirement} = 40 \text{ Imperial gpm at } 1000 \text{ rpm}$$

$$\text{U.S. specifications} = \frac{40 \times 278 \times 1200}{231 \times 1000} = 58 \text{ U.S. gpm at } 1200 \text{ rpm}$$

If pump ratings were expressed in cubic inches per minute, only the correction for motor speed would have to be made in the above calculations.

• ***Lets Use KCM***—Cubic inch per minute (cim) ratings would be unwieldy 5-figure numbers for large pumps.

For big volume pumps useful ratings might be the kcm (1000 cim) from "kilo" and ccm (100 cim) from "centi".

Using this we could develop a standard for model numbers of pumps. The rating could be shown on circuit diagrams. We already have "PF" for fixed volume pumps. Make it read:

$$\frac{PF}{11.20}$$

to show that the pump delivers a fixed volume of 11,200 cubic inches per minute at the rated speed. ▼▼▼

The ARROW AUTOPNEUMATIC CONTROL is the answer to your compressed air problems

Write for Free Catalog

ARROW TOOLS, INC.
1934 S. Kostner Ave.
Chicago 23, Illinois

CIRCLE 4 ON READER SERVICE CARD

BREATHER-FILTER

protects housings, crankcases, storage tanks.

The Air-Maze breather-filter keeps dust out of engine and compressor crankcases, gear-cases, hydraulic equipment, liquid storage tanks and machinery. Types and sizes available in both oil-wetted and oil bath models to protect every vented housing.

In the oil-wetted type, dust is impinged on a series of oil-wetted wire baffles. In the oil bath type, used where the dust concentration is unusually high, the filter media is enclosed in a bowl. Outside air must first pass through the oil, then the filter media, before entering crankcase or housing. Also functions as a backfire flame arrester.

Available in sizes from ⅛" to 3½". Permanent, all-metal, easily cleanable. Write for booklet BC-453. Made by AIR-MAZE CORPORATION, Cleveland 28, Ohio.

INVESTIGATE MARK-TIME MECHANICAL TIMERS FOR O. E. M. USES

NEW **FREE** CATALOG

ELIMINATE ELECTRICAL FAILURES

Custom-built timers in small, medium or large quantities are our specialty. Over 3,000 **different** kinds of timers presently being produced. Timers can be designed to ring bells, flash lights, turn valves, cut cords, stop, start or operate electrical or mechanical equipment, etc. Timing ranges from seconds to hours. Unlimited uses for practically all products — all fields.

SECRET

Current use in guided missile program includes four major areas — TESTING, LAUNCHING, FIRING, RECOVERY. R. & D. work welcome.

M. H. RHODES, INC. HARTFORD CONNECTICUT

CIRCLE 112 ON READER SERVICE CARD

REPUBLIC VALVES FOR EVERY INDUSTRY

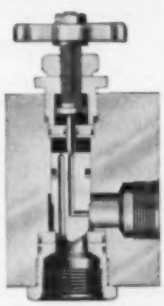
EXTRA HIGH PRESSURE FINE METERING

HIGH PRESSURE NEEDLE VALVE

10,000 psi hydraulic service. Forged stainless steel one-piece body. Panel mounting. Good flow characteristics, fine metering, easy to turn. Water, gas, oil and vacuum service, ⅛" to ½" pipe or straight thread tube connections.

MICROMETER ADJUSTMENT NEEDLE VALVE

Best for extra fine metering. Micrometer adjustment, precision taper stem. 5000 psi service –65° to 350°F., oil, water, etc. Brass, aluminum alloy, steel, or stainless steel body. ⅛" and ¼" sizes. Premolded or O-ring packing. Panel mounting.



5000 psi THROTTLE-FLO VALVE

Accurate throttling up to 5000 psi. Finger tip control. Pilot operation of large dynamically balanced piston. Full flow, yet accurate to 1/100 gpm through entire range. Positive seal. Low pressure drop. Aluminum alloy, ½", ¾", 1" internal straight thread connections. Hydraulic seals — others available.

HYDRAULIC BLEEDERS

Primarily used for bleeding air from hydraulic systems, for working pressures to 3000 psi at temperatures from –65° to 180°F.

Fluid control valves of many types have been developed and are manufactured by REPUBLIC. A wide line of quality standard valves includes needle, globe, check, plug, selector and relief valves, as well as other units for industrial, chemical, aircraft, missile and ground handling equipment.

Specialists in valving and manifold design to meet your specific application. Write for catalog.

Distributors in principal cities coast to coast

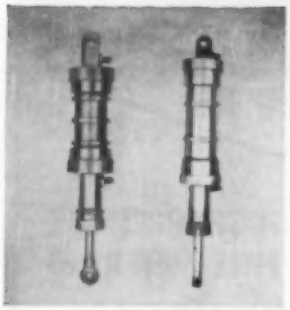
RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

CIRCLE 110 ON READER SERVICE CARD

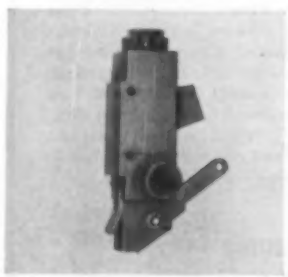
FROM THE BLAZING INFERNO
OF AN AFTERBURNER
TO THE TORTUROUS VIBRATION
OF A MISSILE...

KIDDE COMPONENTS SOLVE YOUR PNEUMATICS PROBLEMS!



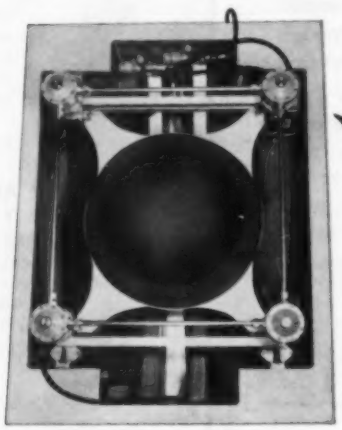
PNEUMATIC ACTUATORS: High pressure, for use in hot gas servo systems or in afterburner nozzle area control and thrust reverser controls.

PRESSURE SWITCH: Controls cut-in and cut-out compressor pressures. Hermetically sealed, accurately maintains system pressure and serves as system pressure indicator.

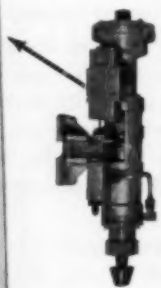


CONTROL VALVE: 5000 psi, manual. Controls air flow to actuating components from supply source. Can be actuated directly by hand, cable pull, or other manual means.

METAL STORAGE CYLINDERS: 5000 psi—have moisture drain fittings which also provide connecting port between the cylinder and the rest of the pneumatic system.



Vibration Isolation System



Vibration Isolator

Newest Kidde development: The Pneumatic Vibration Isolation System. Employing relatively inexpensive components, it maintains desired low natural frequency and reduces the relative displacement at various load conditions.

The system shown above is one of several Kidde pneumatic vibration isolation system programs for protecting delicate missile control systems from undesirable vibratory disturbances and great transients in "g" loading which would affect accuracy of control. The component in the inset photo incorporates the system's mechanical and air snubbers, air spring, servo valve and passive isolator.

Research on projects like this new vibration isolation system goes on constantly in Kidde's vast creative pneumatics engineering department. For more information on any Kidde components, or help in solving specific pneumatics problems, write or call Kidde today.

Kidde

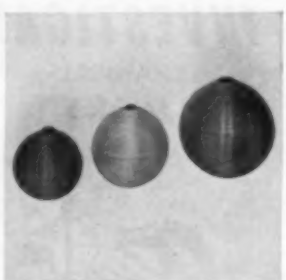
Walter Kidde & Company, Inc.
Aviation Division
416 Main Street, Belleville 9, N. J.

District Sales Engineering Offices:
Dallas, Tex.—Dayton, Ohio—St. Louis, Mo.
Seattle, Wash.—Van Nuys, Calif.—Washington, D. C.

Walter Kidde-Pacific, Van Nuys, California
Walter Kidde & Company of Canada Ltd., Montreal

SOLENOID VALVE: New one-half inch pilot-operated valve. Extremely fast response time (25 milliseconds) for use in systems involving pulsating, high pressure gases.

QUICK DISCONNECT: Double-check — permits fast coupling or uncoupling of components without pressure loss. Has pressure check in both inlet and outlet unit.



FIBERGLASS SPHERES: Non-shatterable, 5000 psi. Feature very high strength-to-weight ratio. High impact resistance, excellent chemical immunity.

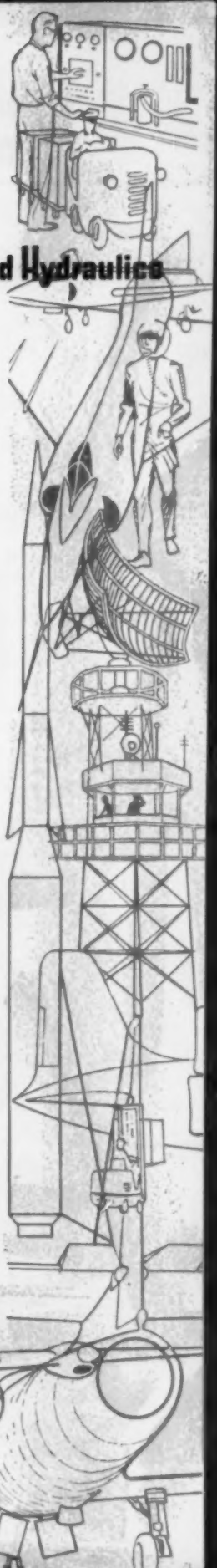
PORTABLE GROUND SERVICE CART: 4cfm compressor, drive unit, air driers and pneumatic storage sphere. Provide service at either 3000 or 5000 psi.

CIRCLE 79 ON READER SERVICE CARD

AVIATION SECTION

Applied Hydraulics

APRIL 1958



SPECIAL REPORT — POWER UNITS FOR AIRCRAFT AND MISSILES

Aircraft Hydraulic Pumps 126

A roundup of characteristics of available aircraft pumps—speeds, pressure ratings, flow rates, weight.

Airborne Compressors 130

Pressure ratings, delivery, drives, size, weight, construction of air compressors for airborne service.

AVIATION NEWS FROM THE FLUID POWER FIELD 134

AVIATION COMPONENT DATA 136

EDITORIAL ADVISORY BOARD

WAYNE S. BOALS Pantex Mfg. Corp. • **HAROLD E. WELLS** Bendix Aviation Corp. • **H. G. CONWAY** Short Bros & Harland, Ltd. • **RALPH E. MIDDLETON** Lockheed Aircraft Corp. • **HOWARD FIELD, JR.** Convair, A Division of General Dynamics Corp. • **W. F. TALBOT** Northrop Aircraft, Inc. • **ALBERT WEISSKOPF** Grumman Aircraft Engineering Corp. • **KENNETH W. DUBOIS** Douglas Aircraft Co.

Aircraft hydraulic pumps

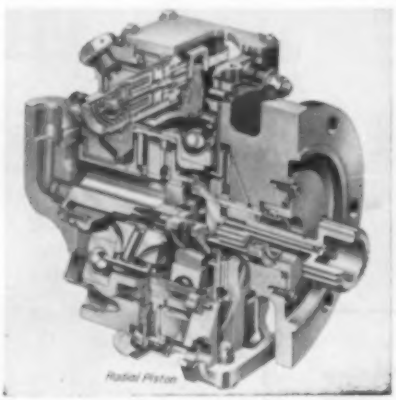
AIRCRAFT hydraulic pumps work the same as some industrial pumps, but aircraft pumps are aimed at highest efficiency and lowest weight. Cost is not nearly so important as it is in industrial applications.

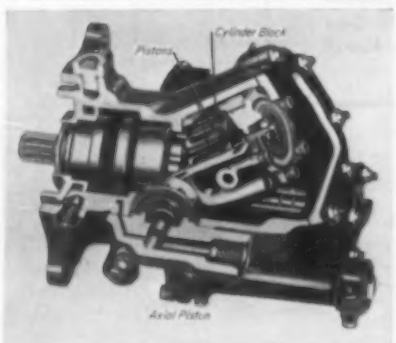
Other requirements peculiar to aircraft pumps are: high operating speeds and operation over a wide temperature range. High operating speeds are needed for several reasons which are related to weight reduction. At higher speeds pumps can be lighter because pump output is almost directly proportional to speed. Bearings and other pump parts must, of course, be designed for the stresses of high speeds.

High speed also reduces pump drive weight. If a pump can be driven at the same speed as an aircraft engine, there need be no reduction gearing. If the drive is an electric motor, high speed permits considerable reduction in motor weight.

Ability to work at high temperatures and over a wide temperature range is needed because these are aircraft service conditions. Most of the difficulty in designing a pump to work at high temperatures results from limitations of heat resistant fluids. Lubricating properties are not usually as good as those of common industrial hydraulic oils.

• **Design**—Pumps for aircraft use are most often axial piston, radial piston and reciprocating plunger types, Figure 1. These have high efficiency and high pressure ratings. High pressures





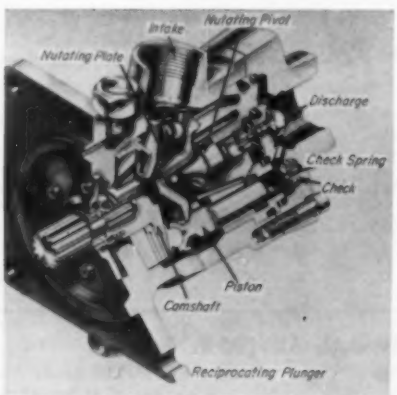


FIG. 1. PUMPS USED AS PRIMARY SOURCES of hydraulic power in aircraft hydraulic systems are radial piston, axial piston, and reciprocating plunger types.

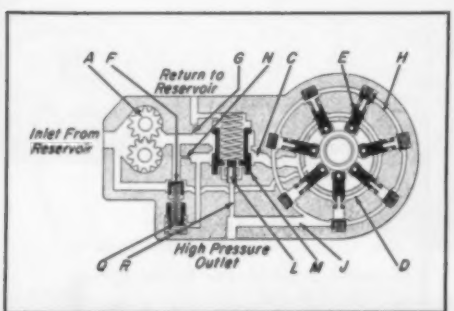
FIG. 2. SCHEMATIC DIAGRAM of an internally-unloaded reciprocating plunger pump. The low-pressure or supercharge pump delivers oil to the main pump through passage *C* and inlet annulus *D*. Surplus fluid from the supercharge pump is bypassed by relief valve *F*. Some of the fluid returns to the gear pump inlet, some goes to lubricate the main pump, and a portion returns to tank through orifice *G*.

The main pump delivers through annulus *H* and passage *J*. Main system pressure is applied to actuating piston *L* which controls unloading valve *M*. When pressure builds up to the unload value, piston *L* moves valve *M* up to block flow to the main pump except for a small flow through orifice *N*. The main pump creates a partial vacuum under piston *Q* to lower the first stage relief pressure, and thus further reduce the power input to the pump. Performance curves show the results.

reduce the size and weight of the pump for a given horsepower rating. High pressure also keeps actuators small and light, since force developed by an actuator is proportional to pressure. Maximum pressure rating of U. S. made aircraft pumps is 3000 psi; British pumps are 4000 psi. Volumetric efficiencies range from 85 to 96%. Overall efficiencies are from 80 to 92%.

Light materials, aluminum, magnesium and zirconium are used wherever possible. Aircraft pumps have weights of less than 0.4 lb per delivered horsepower. Miniaturized versions may develop as much as 6 hp per lb.

• **Types and Applications**—Fixed-displacement pumps may be used in all applications. They are usually used when the pump drive is an electric motor or other type of motor which can be easily stopped and started to provide pump unloading when its output is not required. Hydraulic unloading of fixed-displacement piston pumps is possible when an accumulator is used. However, unloading valve weight will increase system weight unless more than



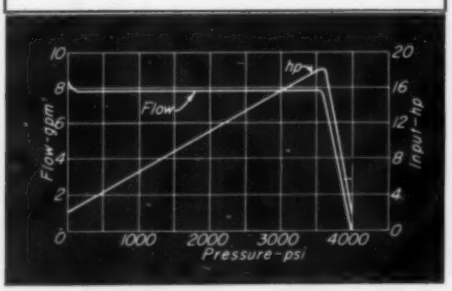


TABLE 1—AIRCRAFT PUMP CHARACTERISTICS

Pump Type	Pressure Rating (psi)	Delivery at rated speed (gpm	Rated Speed (rpm)	Approx Weight (lb)	Max Intermittent Speed (rpm)
Axial Piston, Fixed Displacement	3000	2.75	6960	2.1	10450
	3000	4.33	5550	4.1	8330
	3000	6.76	4440	4.9	6660
	3000	9.4	3770	6.8	5660
	3000	12.8	3240	10.0	4850
	3000	17.5	2770	16.5	4150
	3000	23.4	2390	22.1	3590
	3000	31.4	2060	32.6	3090
	3000	43.0	1760	44.5	2640
Axial Piston, Variable Displacement	3000	2.99	7280	9.5	9100
	3000	4.73	5810	6.7	7245
	3000	7.36	4630	8.7	5800
	3000	10.2	3940	13	4920
	3000	13.9	3370	16	4230
	3000	22.1	3370	21	4230
	3000	29.3	2880	27	3610
	3000	39.6	2490	—	3120
Radial Piston, Variable Displacement	3000	2.3	12000	2.7	—
	3000	4.8	12000	4.1	—
	3000	9.0	12000	4.8	—
	3000	10.6	10000	7.3	—
	3000	16.7	10000	8.8	—
	3000	30.4	8000	18.0	—
	3000	17.8	3750	18.0	—
	3000	48.6	8000	23.7	—
	3000	28.5	3750	23.7	—
Reciprocating Axial Plunger, Variable Displacement	3000	6.0	4500	11.2	—
	3000	7.0	4500	7.9	—
	3000	11.0	4500	12.7	—
	3000	11.8	4500	12.0	—
	3000	25.8	4000	26.5	—
	3000	7.2	4500	9.3	—
	3000	17.6	4500	24.2	—
	3000	.88	4500	3.5	—
	3000	1.7	4500	4.2	—
Reciprocating Axial Plunger, Fixed Displacement	3000	1.7	4500	4.1	—
	3000	3.0	4500	4.1	—
	3000	6.8	4500	6.3	—
	3000	9.0	4500	10.0	—
	3000	1.7	4500	2.5	—
	3000	3.7	10000	1.9	—
	3000	2.9	4500	3.6	—
	3000	10.5	10000	4.0	—
Reciprocating Radial Plunger, Integral Unloading	4000	7.8	4000	13.5	—
	4000	9.0	4000	14.9	5000

TABLE 2—FLUID TEMPERATURE RANGES

Fluid	Temperature Range ° F	
MIL-O-5606	−65	+275
Skydrol 500	−65	+225
MIL-H-7808	−65	+400
Oronite 8515	−65	+400
OS-45-1	−65	+400
Versilube F-50	0	+600
GE 81717	0	+600

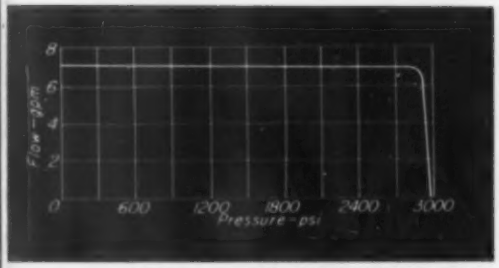
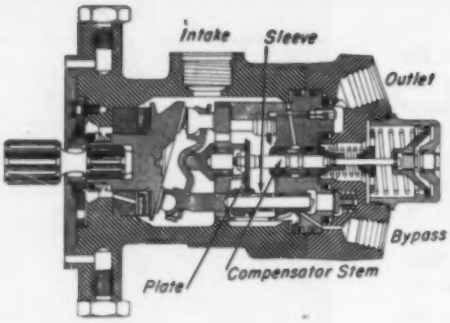


FIG. 3. PERFORMANCE CHARACTERISTICS of a pressure-compensated, variable-delivery pump.



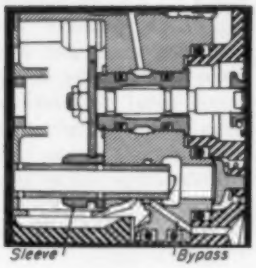


FIG. 4. PRESSURE COMPENSATION in a reciprocating plunger pump is obtained by applying high-pressure oil to a compensator stem which works against springs. When set pressure is reached, the stem moves to the right. This moves sleeves, attached to a plate on the end of the stem, to the right. These sleeves slide on the plungers. With the sleeves moved to the right (See enlarged section at right) relief holes in the plungers remain uncovered during the plunger stroke, and oil escapes through the relief holes and bypass passages instead of being pumped.

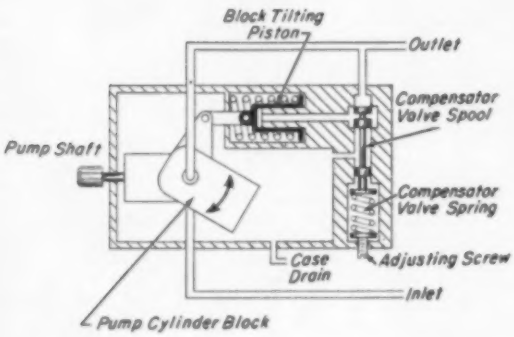


FIG. 5. PRESSURE COMPENSATION in an axial-piston pump is accomplished by applying high-pressure oil to a spring-loaded actuator piston, through a compensator valve. When pressure of the oil on the valve spool exceeds spring pressure, oils is supplied to the piston to move pump cylinder block and decrease delivery.

one pump is unloaded by the same valve. Some fixed-displacement pumps have an integral unloading system, Figure 2.

Since pump unloading is so important to avoid heating the fluid, most aircraft use variable-delivery pumps with pressure-compensator control. This type of control keeps the pump flow at maximum until system pressure reaches the preset cutoff point. Pump displacement is then cut to a value required to maintain this pressure. A characteristic curve of pump performance with this type of control is shown in Figure 3. Figures 4 and 5 show ways to get this performance. Flow is not reversible in the pumps shown.

Pressure-compensated, variable-delivery pumps power actuators for all sorts of services. Actuators for landing gear, wing flaps, and control surfaces may all use fluid from these pumps. When this type of pump is used, servo valves must, be used for controlling flight control actuators.

Variable-delivery pumps with reversible flow, are included in complete servo systems for positioning or controlled-speed power transmission. They may also be used as a part of a manually-controlled, variable-speed transmission. Servo units come as a complete package for electrical, mechanical or hydraulic input.

• **Fluids and Temperature**—Characteristics of most aircraft hydraulic pumps are summarized in Table 1. Fluids for aircraft hydraulic systems are detailed in Table 2. Pumps are available to operate with these fluids in these temperature ranges. Life at elevated temperatures is less than at lower temperatures. However, they will work. Pump manufacturers should be consulted on tougher jobs.

Basic characteristics of nearly all types of positive-displacement pumps are discussed in the article on page 79 in this issue. That article should be interesting corollary reading. A more detailed discussion of the effects of pump speed on volumetric and overall efficiencies is included. ▼▼▼

APPLIED HYDRAULICS acknowledges with appreciation the cooperation of the following companies in supplying information for this article.

Dowty Equipment Ltd (Fig. 2) .....Cheltenham, England

Hamilton Standard, Div. United Aircraft Corp. (Fig. 1a) .....Windsor Locks, Conn.

Kellogg Div., American Brake Shoe Co. .....Rochester, N. Y.

Vickers, Inc. (Fig. 1b, Fig. 5) .....Detroit, Mich.

Watertown Div., New York Air Brake Co. (Figs. 1c, 4) .....Watertown, N. Y.

CIRCLE 40 ⟶

POWER FOR MISSILE & AIRCRAFT HYDRAULIC SYSTEMS

Eastern Aviation Hydraulic Pumps set new standards for performance, yet are the smallest, most lightweight ever made.

By meeting customer requirements and government specifications with precise detail, Eastern Pumps give reliable long-term service.

Hundreds of models, close-coupled to electric motors with speeds to 24,000 RPM, can be furnished for your special systems. You gain the advantage of economical mass-produced components custom-engineered into whatever configuration is needed. Performance is from .015 to 1.5 GPM, 0 to 3000 PSIG, with theoretical displacements from .0021 to .0419 cubic inches per revolution. A variety of bearing combinations handle different types of fluid and operating pressures.

Missile and aircraft system engineers have discovered Eastern Pumps do the same job as units that use greater space and weigh far more. Applications have included circulating coolant in bomber guidance system, providing hydraulic power for ground control of jet, charging accumulator in an in-flight refueling system, furnishing an APU system with power to a missile, and countless others.

For your next project, contact Eastern for creative engineering help that really helps.

Write for NEW Aviation Bulletin 350 describing the above units and larger-capacity pumps.

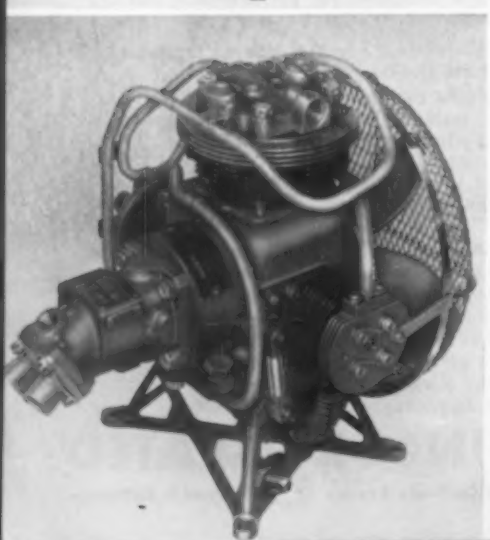
AVIATION PRODUCTS

EASTERN INDUSTRIES, INCORPORATED

100 Skiff Street • Hamden 14, Conn. **West Coast Office: 1608 Centinela Avenue • Inglewood 3, California**

Airborne compressors

DESIGN and construction of airborne compressors is dictated by their application. They have small size, low weight, and high pressure ratings compared to most industrial compressors. Reasons for small size and light weight are obvious. But why high pressures?



TYPICAL AIRBORNE air compressors. Units are air cooled, multistage types. Unit at top is for engine drive. Lower compressor is unit type with cooling fan, mounting base, and hydraulic motor drive.

Higher pressures are required of aircraft compressors for several reasons. First, they reduce actuator size, because total force is the product of piston area and available pressure. Second, more energy can be stored in the same volume if pressure is increased. This gives valuable savings in receiver size and weight. In military aircraft, small receiver size is very important, since the small receiver is not as liable to be hit by enemy gunfire.

High pressures also simplify removing moisture from the compressed air. Figure 1 shows the amount of moisture in saturated air at various temperatures and pressures. Since air can hold so much less water at higher pressures, there is less danger of condensation, freezing and resulting failure in the system. Since aircraft systems must often work at very low temperatures, this is important.

• **Construction**—Airborne compressors are air-cooled, multistage, reciprocating machines which operate at relatively high speeds. This construction results in light weight, small size, and high output pressure. They are ordinarily supplied as complete units with necessary pre-coolers, intercoolers, aftercoolers and control valves. Valves include the high-pressure relief valve, interstage relief valves, and the inlet air regulator. When air at pressure above atmospheric is supplied to the compressor to minimize or reduce the effects of altitude on output, inlet air regulators control inlet pressure to the first stage. Figure 2 shows how performance is affected by altitude. Inlet air-pressure regulators may be set for constant inlet pressure, or they may maintain constant pressure until a certain altitude is reached. Pressure will then start to decrease with altitude.

Air for pressurizing the inlet of an airborne compressor is obtained by bleeding air from the compressor of a jet engine or some other source in the aircraft. Whether inlet pressurization is needed or not is determined by operating conditions of the aircraft. If most of the operating time is at high altitude, pressurization is necessary. If much of the flight time is at low or medium altitudes, cost of the inlet pressure regulator and precooler which is necessary when inlet air is hot may be hard to justify. In some cases the length of tubing joining the air source and compressor inlet may provide all the precooling needed.

Other items which are provided as part of a compressor package include moisture separators, pressure switches for control, cooling fan, a drive—electric, hydraulic, or air turbine, and the drive controls. Compressors are also provided for direct drive from the aircraft engines.

• **Selection**—Selection of an airborne compressor or compressor package consists of matching requirements with characteristics of available compressors as closely as possible. Important characteristics of typical compressors and packages are in Table 1. For optimum performance, pressure supplied to actuators in an air-

CIRCLE 103 ⟶

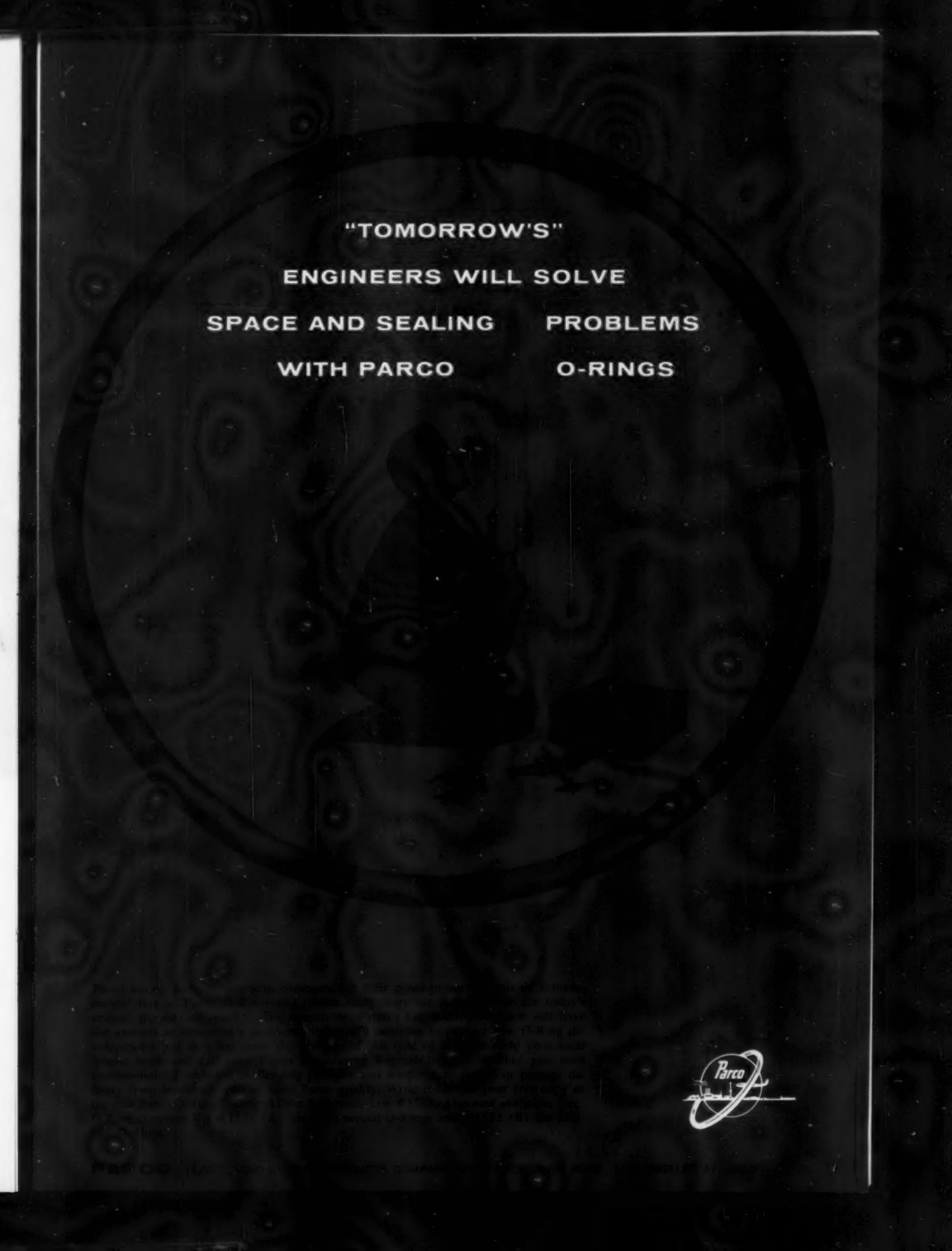

"TOMORROW'S"
ENGINEERS WILL SOLVE
SPACE AND SEALING PROBLEMS
WITH PARCO O-RINGS
Parco

TABLE I—AIRBORNE COMPRESSOR CHARACTERISTICS

Manufacturer	Pressure Rating (psi)	Delivery (scfm)	No. of Stages	Drive	Weight (lb)	Package Size L x W x H (in.)
Cornelius Co.	1500	0.4	3	28-v d-c motor	8.94	12-13/16 x 10-9/32 x 6-25/32
	3000	2	3	28-v d-c motor	16.25	13-3/4 x 9-7/32 x 10-3/4
Walter Kidde & Co., Inc.	3000	2	4	200-v 400-cycle mtr	30.5 16.5	16 x 9-3/4 x 12 11 x 9-1/4
	3000	4	4	Hyd. mtr. (1500 psi)		x 11-1/2
	3000	8	4	Hyd. mtr. (3000 psi)	30	11-9/16 x 16 x 14-7/8
	3000	25	4	Aircraft Engine	23	10-1/2 x 10-1/2 x 16
	5000	12	4	Hyd. mtr. (3000 psi)	33.5	23 x 9-1/2 x 9-7/8
M. C. Mfg. Co.	3000	2	4	26-v d-c mtr.	24.8	
	3000	2	4	Aircraft engine	11.5	6.98 x 9.4 x 9.4
	3000	2	4	Hyd. mtr. (3000 psi)	13.98	11.12 x 8.75 x 9.98
	3000	2	4	200-v, 400 cycle mtr.	22.42	
	3000	4	4	Hyd. mtr. (3000 psi)	15.40	
	3000	4	4	Hyd. mtr. (1500 psi)	16.80	
	3000	4	4	Aircraft engine	11.90	
	3000	4	4	Hyd. mtr. (1500 psi)	18.77	12.06 x 9.12 x 11.48
	3000	4	4	200-v, 400-cycle mtr.	31.9	
	5000	2	4	Aircraft engine	11.70	

craft pneumatic system should be from 15 to 40% of receiver pressure, Figure 3. Thus compressor pressure rating should be from 2½ to 6½ times that required for actuation. A pressure reducing regulating valve is used between the receiver and the actuator circuits. Required actuator pressure is determined by force-and size required of the actuator.

Capacity requirement must be determined from actuator operating cycles. Simply adding the total capacity required per unit of time and selecting a compressor which will supply this can result in an undersized unit. There may be certain periods when compressor capacity cannot be used because the receiver is already fully charged. This can only be determined by careful mapping of the cycle and analysis.

Type of compressor drive to choose is set by what's available on the airplane. Sufficient capacity, compressor location, and other factors must be balanced against each other. Weight of the different types of drives is one of these other factors. For example, if the aircraft has a 3000-psi hydraulic system and the compressor can be located so air lines and hydraulic lines are not too long, a hydraulic motor should be used. The same kind of reasoning may, of course, lead to another drive. ▼▼▼

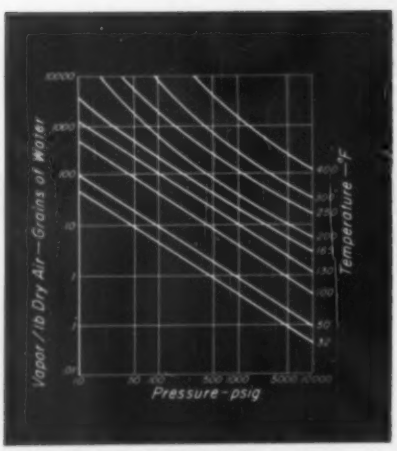


FIG. 1. COMPRESSION reduces the amount of water vapor which air can hold. This simplifies moisture removal, important in aircraft pneumatic systems.

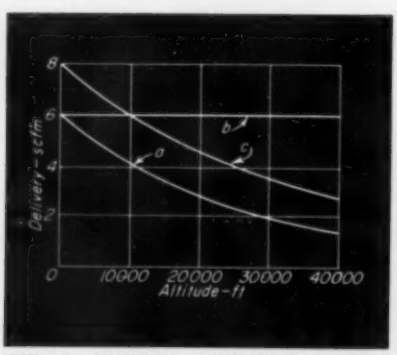


FIG. 2. CURVE *a* SHOWS how compressor output would decrease with altitude if no inlet pressurization were used. Curve *b* shows that if inlet pressure is held at 14.7 psia, by pressurization, output is constant at all altitudes. Pressurization at a constant level above atmospheric would result in performance shown by curve *c*. This might be acceptable.

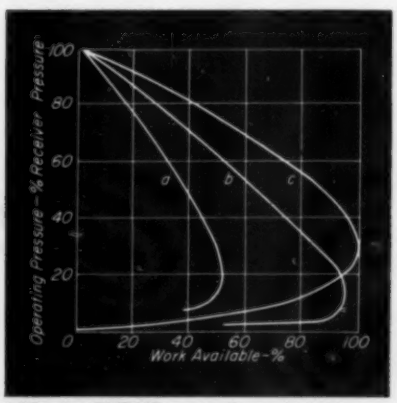


FIG. 3. CURVE *a* is for adiabatic expansion in the receiver with air used without expansion in the actuator. Curve *b* is for isothermal expansion in the receiver with the air used without expansion in the actuator. Curve *c* is for adiabatic expansion in the receiver and adiabatic expansion in the actuator.

Great advances in design . . .

NEED THE ADVANCEMENT IN WEAR RESISTANCE PROVIDED BY FLAME-PLATING BY LINDE

Lockheed's F-104A Starfighter, newest weapon of the Air Force, is the most advanced airplane of its type. To give them the greatest possible resistance to extreme conditions, bearing surfaces *(arrows)* of hot air valves used in the F-104A are Flame-Plated with tungsten carbide. Flame-Plating provides the wear-resistant coating needed to withstand the high unit loading and temperature extremes jet plane parts undergo.

Stratospheric altitudes . . . supersonic speeds . . . extreme temperatures subject jet plane parts to almost incredible conditions of heat and abrasion. To assure perfect operation in all circumstances, bearings of hot air valves in the Starfighter are Flame-Plated. A tungsten carbide coating, applied by LINDE's unique method, is the only material tried that successfully eliminated galling and provided a low coefficient of friction over the required service life of the part. With the part Flame-Plated, practically no wear occurred. This LINDE process is now a regular production procedure.

Flame-Plating is LINDE's special process for protecting metal parts from wear, abrasion, and fretting corrosion. Tiny particles of tungsten carbide or aluminum oxide are literally *blasted* onto the metal surface. Since the temperature of the part being coated seldom exceeds 400 degrees F., there is little or no risk of changes in its shape or metallurgical properties. Flame-Plated coatings can be applied from .002 to .010 inches thick, and used as coated or finished to 0.5 microinches rms. Practically all metals can be Flame-Plated—aluminum, magnesium, molybdenum, titanium as well as copper and steel.

Your own design may be improved by Flame-Plating. Find out how, by writing for a copy of the booklet "Flame-Plating," F8065. Address Flame-Plating, Dept. AH-4, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK

UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

AVIATION NEWS

from the fluid power field

R. J. Kiernan has been appointed to the West Coast Sales Engineering staff of the **Weatherhead Company,** Aviation Division, in Glendale, California. Kiernan was formerly with Norden-Ketay of Gardena, California.

Past president of the Detroit section, American Rocket Society, **Fred A. Klemach** has been made Senior Staff Engineer, Aero Hydraulics Div., **Vickers Inc.** In recent years, Klemach has been a consulting engineer on missiles, rockets and jet engines as well as president of the National Design and Research Corp. He will specialize in missile applications.

R. J. Kiernan
Weatherhead Co.

F. A. Klemach
Vickers, Inc.

A. W. Laird
N. Y. Air Brake Co.

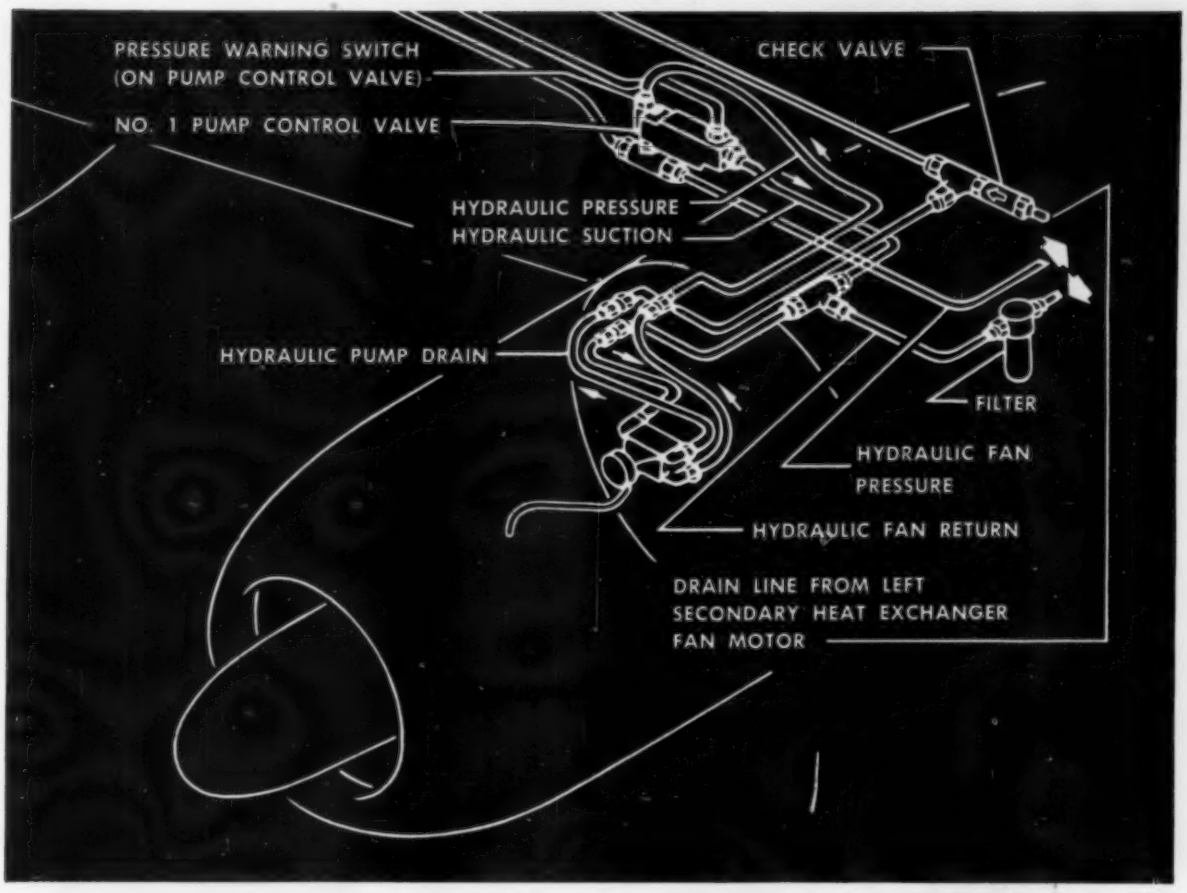
A. Wilson Laird, vice president in charge of advanced planning and government relations for **New York Air Brake Co.,** has been appointed to the board of governors of the Aircraft Industries Association. Laird has been director of Hydraulic Engineering and assistant to the president as head of all New York Air Brake Co., hydraulic operations in recent years.

TOUGH BIRD . . .

. . . is the Convair 880 transport. A section of the fuselage is being tested here to prove it. Hydraulic cylinders are used to try and pull the section apart after a 4-in. saw cut is made in the aluminum alloy skin. Total longitudinal pull is 350,000 lb or 22,000 lb per sq in. Repeated cycling was necessary to promote growth of the cut and the cut could not be lengthened appreciably when less than 4-in. long.

Fluid Flammability—*Research On The Flammability Characteristics Of Aircraft Hydraulic Fluids* is the title of a 34 pg report prepared by M. G. Zabetakis, A. L. Furno and J. J. Miller, Jr., U. S. Dept. of the Interior Bureau of Mines, for Wright Air Development Center, U. S. Air Force, May 1957, 34 pages. Order 1331193 from OTS, U. S. Dept. of Commerce, Washington 25, D. C., $1. The report presents the results of minimum spontaneous ignition temperature tests conducted on seven hydraulic fluids. Fluids were tested in contact with seven surfaces found in aircraft under conditions likely to be encountered in practice.

Macmillan Company announces publication in U.S. of Volumes I and II of **Aircraft Hydraulics by Conway.**



Where you can't afford a failure . . .
Plan a Purolator filter as part of your system

Most hydraulic systems break down immediately unless they are protected by adequate filtration. And it takes more than correct filter placement to assure adequate filtration — it takes the best filter you can get as well. That's why it pays to use Purolator Micronic® filters. They give you the fullest protection. The reason? Micronic elements — which provide controlled porosity and maximum filtration effectiveness with removal of particles as small as .000039 inch. And because they're made of plastic-impregnated cellulose, Purolator's Micronic elements are not affected by high temperature or water.

Filtration For Every Known Fluid

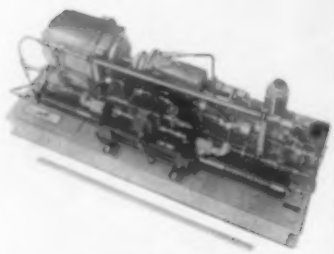
PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

To find out more about proper placing of filters in hydraulic systems, write for our new 32 page "Filtration Manual for Product Designers"—and please enclose 25¢ to cover postage and handling. Address Dept. P4-526.

TE-6



OIL FREE GAS BOOSTER COMPRESSOR FOR TALOS MISSILE PROGRAM. CAPABLE OF 10,000 PSI MAX.

HASKEL

ENVIRONMENTAL HYDRAULIC PNEUMATIC TEST EQUIPMENT

PROPULSION SYSTEM TEST UNIT FOR MISSILE CHECKOUT USED WITH AN EXTERNAL GAS PRESSURE SOURCE.

For precise testing of airborne components and ground checkout of missile and aircraft systems.

Custom designed test equipment built to your specifications, including complete environmental test facilities.
Brochure describing standard units available upon request.

HASKEL ENGINEERING & SUPPLY CO.
1236 South Central Avenue
Glendale 4, California

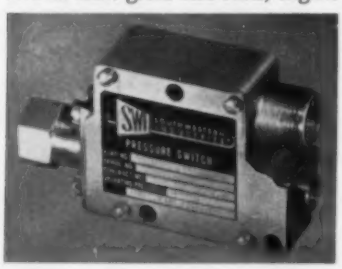
SOME TERRITORIES OPEN FOR REPRESENTATIVES

AVIATION COMPONENT DATA

Pressure Switch

. . . is shock resistant

This switch, already in operation in various missiles, is light weight, high-pressure and vibration damped. Weighing about 0.4 lbs, it operates in inert gases and fuels, engine



and hydraulic oils and aromatic fuels. Unit is designed to withstand vibrations up to 25 G's, from 10 to 2000 cps. Externally adjustable in pressure ranges of 400 to 2000 psi and 2000 to 3500 psi. Operating temperature range —40 to 160 deg. F.—*Southwestern Industries, Inc., Los Angeles, California.*

CIRCLE 500 ON READER SERVICE CARD

Static Seal Valves

. . for extreme temperatures

Valves incorporate the company's line of static seals. The valves are designed to handle extreme temper-

atures involving fuels, oils, gases and other fluids. Photo shows the Skinner static spring seal as an integral part of a poppet valve.—*The Skinner Seal Company of Santa Ana, California.*

CIRCLE 501 ON READER SERVICE CARD

Hydraulic Filters

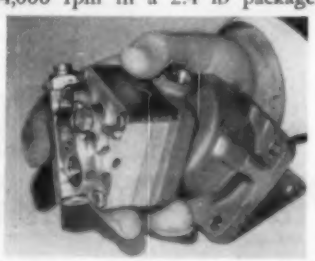
. . . and elements meeting proposed military standards MS-28895, MS-28896, MS-28897 and MS-28898 are shown on two specification sheets including all pertinent information. All dimensions, pressure ratings, temperature ranges, etc. are listed.—*Aircraft Porous Media Inc., Pall Filtration Co., Glen Cove, N. Y.*

CIRCLE 502 ON READER SERVICE CARD

New Variable Pump Design

. . . reduces weight, saves space

Designed for aircraft and missiles, the PV-3906 series gives 3000 psi variable flow to 9.7 gpm at 24,000 rpm in a 2.4 lb package.



This miniaturization gives a 48% weight reduction and 70% space saving over standard variable units. Size and weight of this variable pump is comparable to present fixed displacement models. It is rated for 12,000 rpm max on aircraft; 18,000 rpm max on missiles; and 24,000 rpm for intermittent duty. Volumetric efficiency is 98%. Adaptable to many volume control methods, pumping element is axial piston design.—*Vickers Inc., Detroit, Mich.*

CIRCLE 503 ON READER SERVICE CARD

Controllable Check Valve

. . . weighs 0.8 lb

Designated MC 1727, this check valve may be externally operated by a handle to permit flow in the

reverse direction. Operation of the lever also actuates an AN single-pole electrical switch. Cracking pressure of the check valve is from

2 to 8 psi. Pressure drop at 2.3 gpm in the free flow direction is 25 psi maximum. In the reverse flow direction, maximum drop is 75 psi with the lever fully actuated. Intended for use with MIL-0-5606 fluid, temperature range is —65 to 160 F. Operating pressure ratings are 500 to 1500 psi. Port connections are for 5/16-in. tubing.—*M. C. Mfg. Co., Lake Orion, Mich.*

CIRCLE 504 ON READER SERVICE CARD

Aircraft Hose

. . . with permanently attached fittings for 1500 psi service over a temperature range of —100 to 500 F is described in a newly-issued, four-page bulletin on Springfield "110" Teflon hose. Specifications, assembly data and detailed cross-sections are in the folder. A similar folder gives the same type of data for Springfield "120" Teflon hose with reusable fittings for the same pressure and temperatures.—*Tite-Flex Inc., Springfield, Mass.*

CIRCLE 505 ON READER SERVICE CARD

Power Cylinder
. . . has integral valve and shaft

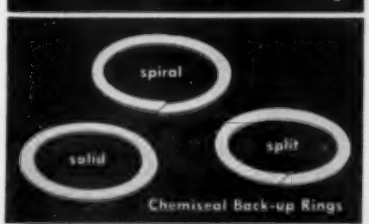
Design provides over-ride for emergency power-off operation and compact packaging for ease of installation and maintenance. Choice

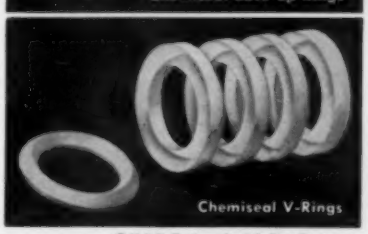
of valve gain curve, low valve force, stroke, porting and mounting to customer order are additional features which lend this design to wide aircraft and industrial application.—*Conair, Inc., Glendale, California.*

CIRCLE 506 ON READER SERVICE CARD

Continued on page 138

Chemiseal® Hydraulic Packings





Because Chemiseal† Hydraulic Packings provide the reliability of TEFLON*, they are preferred by leading engineers for maximum security at vital points in aircraft hydraulic systems.

Chemically impervious, Chemiseal packings require no chemical inspection, have zero swelling in all hydro-carbons, new synthetic hydraulic fluids and solvents.

They offer unsurpassed anti-friction properties, are tough, resilient, non-flammable, long wearing. They have a service temperature range from minus 110°F to plus 500°F.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

© U.S.G. Trademark * du Pont Trademark

United States Gasket
Plastics Division of GARLOCK

CIRCLE 139 ON READER SERVICE CARD

2nd Printing!

Available July 1st

AIRCRAFT HYDRAULIC DESIGN

by GEORGE R. KELLER
Group Leader,
Flight Control Engineering Dept.
Autonetics, A Division of
North American Aviation

First published April 1957, the entire printing was sold out in eight months.

Place your order now to reserve copies of the second printing scheduled for mailing July 1st.

Published by
APPLIED HYDRAULICS Magazine

- **The first book** dealing with hydraulic component and system design for high-speed piloted aircraft and missiles, has been written by a leading aircraft engineer. Developed from practical and theoretical material, the book develops many basic equations including those relating pressure gradient, flow-path dimensions, flow rate, velocity, fluid density, and viscosity.

- **Design of system components** including actuators, valves, pumps, accumulators, transmission lines and seals is discussed. Accumulator theory is presented with a detailed example of proper accumulator selection.

- **Hydraulic servo systems** are diagrammed and the transfer functions developed. Fundamentals of transient analysis technique and frequency response method of servo testing are given. The chapter on high temperature hydraulics outlines present progress in fluids, seals, springs, metals, and other critical components, and indicates future developments and techniques.

The advance of industrial hydraulics in servo components and systems makes this book of great value to designers of industrial equipment as well as aircraft engineers.

$4.50

10 or more $4.00 per copy

The Industrial Publishing Corporation
812 Huron Road • Cleveland 15, Ohio

Please send me ——— copies of AIRCRAFT HYDRAULIC DESIGN

☐ Bill me (order no. ———) ☐ Money order attached

NAME .....

ADDRESS ..... CITY ..... STATE .....

AVIATION COMPONENT DATA

Miniature Relief Valve

. . . for high pressure pneumatic service

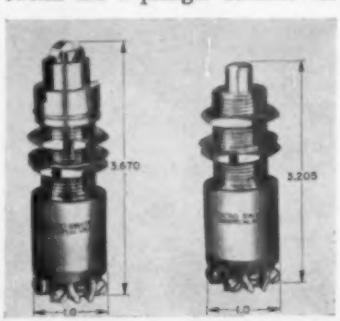
Valve weighs less than ½ oz and measures ⅜ in. hex by 1¾ in. long. Design permits such features as chatter free action, zero leakage up to cracking pressure and quick, positive reseat. The unit has a capacity of 8 to 12 cfm and operates over a pressure range from 200 to 4000 psi. Temperature range is —65 to 250 deg F. Also adaptable to low flow hydraulic service.—*Pneu-Hydro Valve Corp., East Orange, New Jersey.*

CIRCLE 507 ON READER SERVICE CARD

Sealed Limit Switches

. . . for —65 to 600 F

Hermetically sealed, limit switches have two single-pole, double-throw circuits. 12HR1-S switch has a plunger actuator for in-line actuation. 22HR1-S has a roller plunger for operation by cams or slides. Stainless steel actuators will withstand heavy impacts



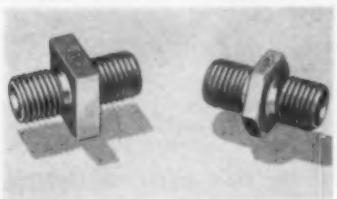
without damage to the enclosed switching unit. Ratings at sea level and 50,000 ft are 5 amp, 28 v dc, resistive and 2 amp, 28 v dc, inductive.—*Micro Switch, Div. Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

CIRCLE 508 ON READER SERVICE CARD

Miniature Relief Valve

. . . for —65 to 400 F

Little larger than the same size union (relief valve is at the left in the photo) a new miniature relief valve meets or exceeds MIL-V-5527. Made in the —4 or ¼-in. tube size, factory set pressure may be anywhere within the range of 1000 to 4100 psi. Maximum operating pressure is 5000 psi. Operating temperature range is —65 to 400 F. Reset pressure is 90% of set pressure. Rated flow at set pressure is 0.25 gpm. Any fluid compatible with 18-8 and 440F stainless steels can be used with the valve. MS 33514 connections are standard.—*Republic Mfg. Co., Cleveland* 11, *O.*



CIRCLE 509 ON READER SERVICE CARD

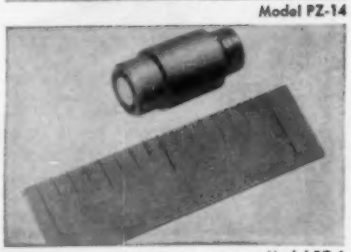
Balanced Relief Valve

. . . for various pressures

Conforming to MIL-V-5523, this valve may also be used as a priority valve. Tests and actual use show excellent reliability. Absence of chatter, surges and leakage are in line with the specification. Units are available in tube sizes up to ¾-in. Weight is 0.63 lb. Various pressure ratings are made.—*Hydraulic Research and Mfg. Co., Burbank, Calif.*

CIRCLE 510 ON READER SERVICE CARD

Model PZ-14



Model PZ-6

Single Kistler Transducer Measures Pressures, Rates, Forces and Acceleration

Precise measurements of diverse pressures, pressure rates, differential pressures, forces, vibration and acceleration can now be made with one Kistler SLM Transducer.

Providing advanced instrumentation for engines, compressors, shock tubes, gun tubes, rockets, hydraulic and pneumatic systems, the self-generating, crystal-type *SLM Pressure Pickup (Model PZ-14)* performs as follows: Measures pressure or pressure rate *directly;* displays all pressures from full vacuum to 3000 psi (100,000 psi with adaptors); covers frequency range of 0 to 50,000 cps; operates continuously at 600° F; withstands intermittent gas temperatures to 3000° F; indicates .1 psi variations at any pressure level to 3000 psi; measures fast pressure transients; makes short term measurements of static pressures. The *SLM Miniature Pickup (Model PZ-6)*, of the same basic design as the *PZ-14 Pickup*, achieves response times approaching one microsecond.

Transient differential pressures can be measured precisely at distant points by using two SLM Pressure Pickups opposite polarity. When pickup cables are joined, signals automatically add or subtract. An Accelerometer Adaptor with a mass, spring-loaded against the crystals, converts the standard SLM Pickup into a precision *Acceleration-Vibration Indicator.* Static calibration is accomplished by turning it upside down in the earth's gravity field, generating a 2G signal.

Utilizing a *Force Adaptor,* the SLM Pickup precisely measures forces to 300 lbs. with less than .005" deflection, and .1 lb. variations at any level. Larger forces may be accommodated by using several pickups with their signal leads joined.

SLM Pickups are coupled to oscilloscopes or recorders with electrostatic amplifiers *e.g.* Kistler Piezo-Calibrator-Amplifier units. A new Amplifier-Calibrator (Model PT-14), single or two-channel rack mounted, has fast response (0 to 200,000 cps), high gain (20), and low output impedance (7000 ohms). For complete information, request Bulletin S-114.

Kistler Instrument Corp., Dept. AH, 15 Webster St., North Tonawanda, N. Y.

Just show this Pribilof Islands playboy the way to go home — orientation will solve his problem. And here's a simple direction you can follow to solve tight seal problems involving metal-to-metal applications: always specify United's Metallic O-Rings.

They fit any application calling for a positive, permanent seal against internal or vacuum pressures up to 10,000 p.s.i., in a temperature range from 70 to 1800°F. They are especially adaptable for sealing cylinder heads, air and hydraulic pressures, high octane fuels, vapors, gases, oils, solvents, chemicals, acids, vacuum and steam connections. Available in various metals and plating finishes, from 3/16" dia. to any size or configuration.

• free 22 page booklet describing United Metallic O-Rings, write (on your letterhead please) to Department M2

UNITED METALLIC "O" RING CORP.
Dayton, Ohio • Box 1035
Division of United Aircraft Products, Inc.

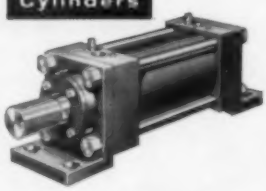
CIRCLE 138 ON READER SERVICE CARD

YES There's a Dependable Sales and Service Organization for H-P-M Hydraulics near You

Pumps

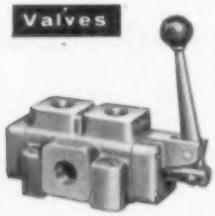
Fixed and Variable Displacement Radial and Gear Type Pumps 1000 psi to 3000 psi—1 to 185 gpm capacity.

Cylinders



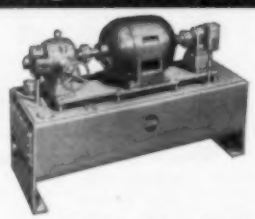
150 to 3000 psi—wide variety of mountings—standard and special types.

Valves



Directional and functional—1000 to 3000 psi—standard threaded, flange and subplate mounting—for every directional and functional valve requirement.

Packaged Power Units



Complete packaged units for hydraulic power to 3000 psi—power and control elements in compact units for versatile application.

BIRMINGHAM 1, ALABAMA
Chas. F. Wheelock & Assoc.
205 South 32nd St.
P. O. Box 1290

CINCINNATI, OHIO
Riggs Engineering Co.
P. O. Box 133
Ludlow, Kentucky

CHICAGO 36, ILLINOIS
Norman Engineering Co.
2115 West Marquette Rd.

CLEVELAND 5, OHIO
Pneu-Hydraulic, Inc.
4330 Ridge Road

CRANFORD, NEW JERSEY
The Roden Company
P. O. Box 305

DALLAS, TEXAS
Tri-State Machinery Co.
3000 Commerce St.

DAVENPORT, IOWA
Norman Engineering Co.
P. O. Box 431

DAYTON, OHIO
Anchor Rubber Company
840 South Patterson Blvd.

DETROIT 38, MICHIGAN
Russell & Olson Company
15820 James Couzens Hwy.

GREENSBORO, N. CAROLINA
Smith-Courtney Company
814-820 Winston Street
P. O. Box 928

HOUSTON 2, TEXAS
The H. L. Thompson Co.
1002 Esperson Building

INDIANAPOLIS, INDIANA
John R. Carlson
4808 Broadway

KANSAS CITY, MISSOURI
Blackman & Nuetzel Mach. Co.
212 Jewell Building
1103 East Armour Blvd.

LOS ANGELES 22, CALIFORNIA
Hydraulic Equipment Co.
5924 East Olympic Blvd.

MILWAUKEE, WISCONSIN
Norman Engineering Co.
743 North 4th Street

MINNEAPOLIS 21, MINNESOTA
Norman Engineering Co.
334 - 40th Avenue N.E.

PALMER, MASSACHUSETTS
Yahn Engineering & Sales Co.
350 Park St.

PHILADELPHIA 8, PENN.
Robert L. Porter
401 North Broad Street

PITTSBURGH 22, PENN.
The Hydraulic Press Mfg. Co.
A Division of Koehring Co.
512-513 Empire Building

RICHMOND 11, VIRGINIA
Smith-Courtney Company
Seventh & Bainbridge Sts.

ROCKFORD, ILLINOIS
Norman Engineering Co.
2500 North Main St.

SAINT LOUIS 8, MISSOURI
Blackman & Nuetzel Mach. Co.
3713 Washington Blvd.

SOUTH BEND 14, INDIANA
Norman Engineering Co.
1627 Southeast Drive

TULSA, OKLAHOMA
Blackman & Nuetzel Mach. Co.
101-111 West Archer Street

WASHINGTON 2, D. C.
J. H. Elliott Company
2101 New York Ave. N.E.

PORTLAND, OREGON
Power Transmission Products
1107 NW 14th Ave.

SAN DIEGO 1, CALIFORNIA
Hoffer Engineering Co.
1115 "F" Street

FILE THIS AD FOR FUTURE REFERENCE

HPM

H811

HYDRAULIC POWER DIVISION

THE HYDRAULIC PRESS MFG. COMPANY

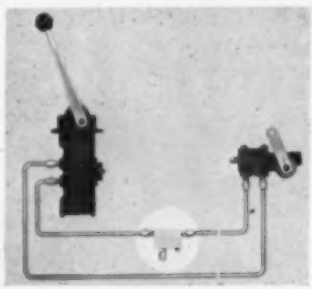
A DIVISION OF KOEHRING COMPANY • MOUNT GILEAD, OHIO, U.S.A.

NEW PRODUCTS

HYDRAULIC REMOTE CONTROL SYSTEM

. . . offers self-bleeding

Features: This remote control system has a filler-bleeder fitting which removes air and also aids in filling the system. This is done by running two lines from the fitting



to the fluid supply and pumping with the control lever. Adjusting the equalizer valve positions the master and slave levers. System is temperature-compensated and can be used for remote control of valves, transmissions, and governors. System will develop 500 in-lb. torque.

The Hydronic Co.
Detroit, Mich.

CIRCLE 304 ON READER SERVICE CARD

LUBRICATOR

. . . meets Navy standards

Features: Lubricator of ½ pint capacity was designed for service in air systems for pressures to 600 psi. Materials are corrosion resistant

and non-magnetic. Lubricator is U.S. Navy approved for shipboard use. Top can be furnished with pipe threads or machined for brazing of tubing.

Harwood Engineering Co., Inc.
Walpole, Mass.

CIRCLE 305 ON READER SERVICE CARD

Continued on page 142

CIRCLE 51 ON READER SERVICE CARD

7 Horsepower . . .
only 7⅝" high!

It's NEW! Variable-speed Model 16AM

GAST AIR MOTOR

Here's compact, explosion-proof power! Only 14⅜" x 8" x 7⅞" — wt. 65 lbs. — yet up to 7 h.p. on 90 lbs. air pressure. Speed variable from 300 to 2,000 r.p.m. with simple valve control. Overloads can't burn it out — stalling does no harm.

Has foot, also tapped holes for flange mounting to your machine. Use as original equipment or in plant to drive hoists, mixers, pumps, fans, etc. Priced at $200.

Write for your copy of Bulletin 16AM.

GAST MANUFACTURING CORP., P.O. Box 117-D
Benton Harbor, Michigan

See Catalog in Sweet's Design File

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

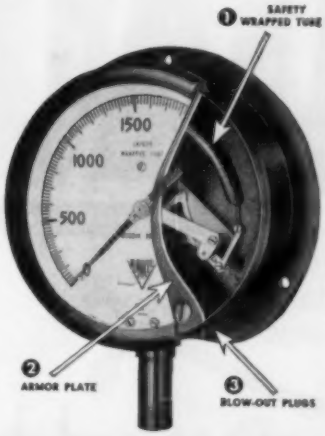
CIRCLE 92 ON READER SERVICE CARD

HI-RELIABILITY GAUGES NOW CATALOGED WITH SPEC. DATA FOR HYDRAULIC APPLICATIONS...

15 p.s.i., or 30" of vacuum, to 20,000 p.s.i., including the

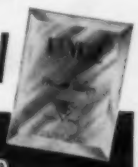
TRIPLE-GUARD SAFETY-TYPE

KUNKLE GAUGES



Backed by 50 years gauge manufacturing experience. Guaranteed accuracy. Tubes, cases and movements to specifications. Bourdon tubes in all metals as required.

NEW



WRITE FOR CATALOG & ENGINEERING DATA

KUNKLE VALVE CO. · FT. WAYNE, IND.

AIROYAL CYLINDERS

are guaranteed against breakage....forever

Airoyal proudly announces a guarantee policy that offers a new benefit to users of air and hydraulic cylinders.

This is our guarantee:

"The Airoyal Mfg. Co. unconditionally guarantees its cylinders—forever—against breakage. Should any Airoyal cylinder, or part of any Airoyal cylinder, break it will be repaired or replaced free of charge, F.O.B. our factory, regardless of the age of the cylinder or the cause of the breakage".

There are no strings attached to this guarantee. We intentionally wrote it to include all possible circumstances. Our thirteen years of experience making Airoyal cylinders have given us the confidence to feel that we will not often be called upon to make good on our offer.

This is what you get out of our guarantee: The knowledge that when you select Airoyal you are placing on your machine a cylinder so rugged and durable that it is guaranteed forever.

We believe our air and hydraulic cylinders are among the finest in their size range—⅝", 1", 1½", and 2" bores. Airoyal cylinders are not the least expensive. The difference in price, however, between the least expensive cylinder and an Airoyal Cylinder is relatively small, especially considering the Airoyal features which make possible our guarantee.

All Airoyal cylinders are shipped with the guarantee statement attached. This will be of value to OEM accounts who may now offer their customers an added benefit.

Standard Airoyal small bore cylinders are suitable for air service to 150 PSI, hydraulic service to 2000 PSI. We've a new catalog ready with more data and prices. Let us send it to you. You'll be pleased to know Airoyal.

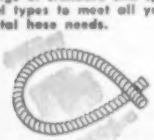
THE AIROYAL MFG. CO., 1990 SPRINGFIELD AVENUE, MAPLEWOOD, N. J.

Flexon

the first name in flexible metal hose and fittings

Proved in use for over 56 years

FLEXON hose assemblies are available in the widest range of standard and special types to meet all your metal hose needs.



FLEXON corrugated or convoluted hose is available in a variety of types and materials . . . stainless steel, steel, bronze, and alloys.

FLEXON fittings are offered in a complete selection for use with all types of Flexon metal hose for any services.

When you specify FLEXON metal hose, you specify top performance. 56 years of user satisfaction have made FLEXON the first name in the field.

Modern volume-production facilities . . . advanced quality control methods . . . an intensive research program . . . all these combine to bring you superior performance and value. And back of it all is the "know-how" only long experience can bring.

A complete line of FLEXON metal hose and fittings is available for your fluid power needs. Find out how FLEXON can help you. For specific recommendations, send an outline of your requirements.

Flexonics *Corporation* MH-42

Mr. Flexon identifies products of Flexonics Corporation that have served industry for over 56 years.

1385 S. Third Avenue • Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

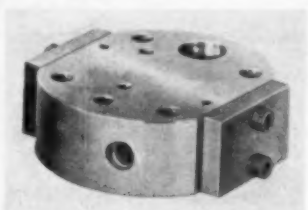
Manufacturers of metal and rubber hose, expansion joints, metallic bellows and aircraft components.

NEW PRODUCTS

AIR VALVE ADAPTOR

. . . for momentary action

Features: This air-index adaptor can be inserted between the head and body on any Ross Skyline series valve and give momentary action to the valve. This action makes the valve hold position each time the solenoid is energized.



Application: An application for the double stroke adaptor is where double solenoid valves are now used. The use of the adaptor can simplify the electrical circuit.

Ross Operating Valve Co.
Detroit, Mich.

CIRCLE 306 ON READER SERVICE CARD

PUMP PACKING

. . . seals high pressures

Designation: UTEX-J

Features: This packing features a flexible lip and non-crushable construction. The same basic design is

UTEX-J PACKING

made in many materials. One style is made for plunger-type pumps and is non-adjustable. This packing has pressure rings and phenolic top and bottom adapters. Pressures to 14,000 psi can be sealed.

Universal Packing and Gasket Co.
Houston, Texas

CIRCLE 307 ON READER SERVICE CARD

EXPLOSION-PROOF SOLENOID VALVES

. . . for high pressures

Features: Valves use the shear-seal principle which has a sealing ring

in constant contact with a mating slide. Solenoids are inclosed in a housing designed for hazardous

locations. Solenoids are direct acting for quick response.

Specifications: Valves are rated for oil and water pressure to 3000 psi and for air to 1500 psi. They are made in 4-way, 3-way, diverter, and shut-off types.

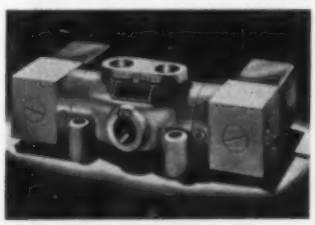
Barksdale Valves
Los Angeles, Calif.

CIRCLE 308 ON READER SERVICE CARD

DIRECTIONAL CONTROL VALVES

. . . mountings are interchangeable

Features: Valves can be operated by lever or cam, air or oil-pilot, or



solenoid. There are three standard, and five alternate spool styles for special circuits. All are interchangeable in the valve body.

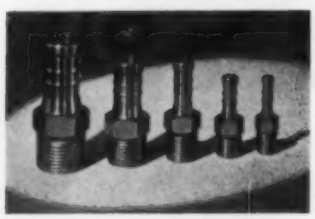
Specifications: Valves are suitable for 3000-psi service and have alloy iron bodies and chrome plated spools.

The Dukes Company Inc.
Schiller Park Ill.

CIRCLE 309 ON READER SERVICE CARD

HOSE NIPPLES

. . . made in stainless steel



Features: A complete line of hose nipples are made of type 316 stainless steel. They are available in sizes from ¼ to 1 in. and are

Continued on page 144

Flexon

a new name in hydraulic hose assemblies and fittings

Backed by over 56 years experience!

The name FLEXON—long a symbol of quality in flexible connections—now identifies a complete line of hydraulic hose and fittings.

Built into this line is the "know-how" gained through 56 years of manufacturing experience . . . 36 years of hydraulic hose experience. Like all products bearing the FLEXON label, these fluid power products are backed by continuous research and rigid quality control . . . and are volume-produced with modern facilities . . . to give you performance and value second to none.

Find out how FLEXON craftsmanship can add dependability to your fluid power applications. For specific recommendations, send an outline of your requirements.

FLEXON rubber hose is available in a wide range of types and sizes for every fluid power application.

FLEXON complete hose assemblies are furnished with a broad choice of standard and special fittings for every pressure range.

FLEXON fittings are available in reusable, pressed on, clamp, flange, S.A.E., and special types, to meet every need.

Flexonics Corporation RH-12

Mr. Flexon identifies products of Flexonics Corporation that have served industry for over 56 years.

1385 S. Third Avenue • Maywood, Illinois
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario
Manufacturers of metal and rubber hose, expansion joints, metallic bellows and aircraft components.

CIRCLE 43 ON READER SERVICE CARD

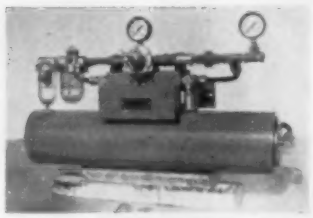
NEW PRODUCTS

designed for maximum flow and greater holding qualities. Hose life is greater due to lower abrasive action of the nipple end. They can be used for air, water, oil and also corrosive fluids.

Band-it Company
Denver, Colo.
CIRCLE 310 ON READER SERVICE CARD

AIR BOOSTER PUMP
. . . boosts shop air

Designation: H-6



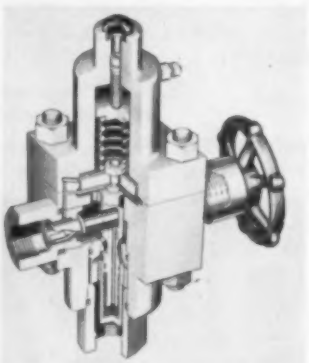
Features: The pump is an opposed cylinder type which is controlled automatically. All component parts are fastened to a mounting plate so that it may be bolted to a press or machine tool. No external power is necessary other than the air to be boosted.

Specifications: Unit has a boost ratio of 2.5 to 1 and an output of 2.5 cfm at 190 psi when using shop air at 80 psi.

Dayton Rogers Mfg. Co.
Minneapolis, Minn.
CIRCLE 311 ON READER SERVICE CARD

CONSTANT FLOW CONTROL VALVE
. . . has hand adjustment

Features: Valve is designed for working pressure of 5000 psi and 45 gpm maximum oil flow. Adjustable orifice is a V-ported sleeve for

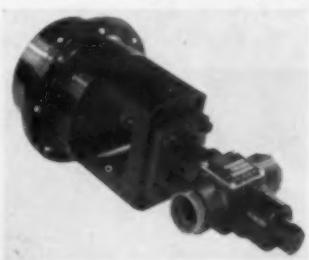


good control at low flows. Micrometer screw adjustment is provided. Pressure differential is controlled by a diaphragm actuated valve; the valve and seat are stellite faced.

Kobe, Inc.
Huntington Park, California
CIRCLE 312 ON READER SERVICE CARD

AIR OPERATED VALVE
. . . meters hydraulic oil

Design: The valve consists of a precision metering valve coupled to



an air-diaphragm actuator. The basic valve is a long stroke, balanced spool type requiring low thrust. The spool has slots to provide

Continued on page 147

CARDWELL STANDARD HYDRAULIC POWER UNIT

SEVERAL HUNDRED POSSIBILITIES! Now, from one Cardwell Catalog, you can specify a "tailored-to-fit" Hydraulic Power Unit from a combination of Cardwell standard parts.

WRITE TODAY for this catalog which describes the new Cardwell Hydraulic Program in detail, including drawings, specifications and price sheets.

DEALERS and DISTRIBUTORS will want this new program, too! One catalog gives you a complete line of Standard Hydraulic Power Units. Write or phone . . .

The CARDWELL MACHINE COMPANY
Franklin at 19th St., Richmond 11, Virginia • Phone MIlton 4-4593

CIRCLE 29 ON READER SERVICE CARD

CIRCLE 120 ON READER SERVICE CARD

Any of **4 Mountings** at **1 Base Price!**

Sheffer Cushioned C10 Series

AIR CYLINDERS

C10 Series

- **HEAVY DUTY,** double acting; adjustable cushions, both ends!
- **BORE** sizes 1½"-6" with strokes up to 24" stocked for 24-hr. delivery!
- **QUICK** delivery on special strokes.
- **HEADS,** sturdy cast semi-steel.
- **RODS,** hard chrome plated; all supplied with wrench flats.

PNEUMATICS SHEFFER HYDRAULICS

Write, NOW, for Bulletin #258

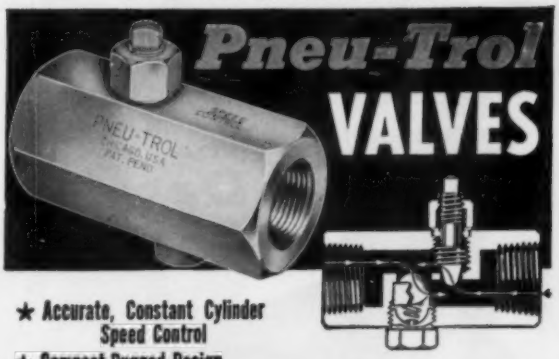
THE SHEFFER CORPORATION

Cincinnati 15, Ohio • Phone: VAlley 1-0320

Manufacturers of the industry's most complete line of air and hydraulic cylinders

SOLD BY LEADING DISTRIBUTORS NATIONWIDE

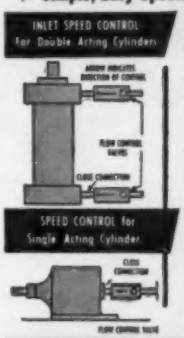
CIRCLE 104 ON READER SERVICE CARD



★ Accurate, Constant Cylinder Speed Control

★ Compact Rugged Design

★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications



Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

Write for illustrated circular and prices.

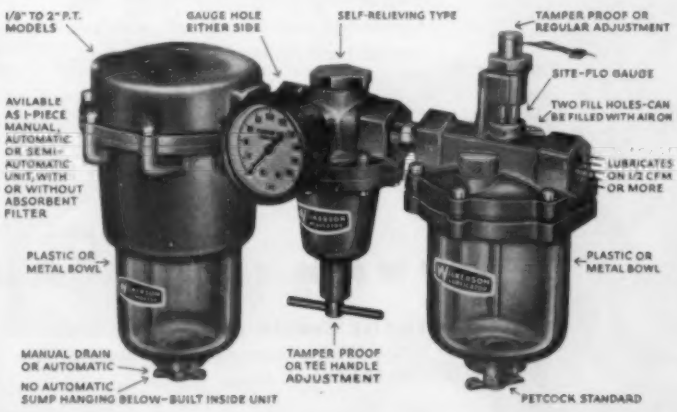
Pneu-Trol DEVICES, INC.

1426 N. KEATING AVENUE • CHICAGO 51, ILL.

"FULL CONTROL" of Compressed Air Operations with WILKERSON COMBINATIONS

UNIT COMBINATION IN VARIOUS SIZES FOR ALL INDUSTRIAL USES

WILKERSON unit combinations are grouped for quick, easy installations in the compressed air system to provide "full control" of all air supplied to tools and equipment. The fully automatic operation of these control packages assures you of positive moisture and contaminant separation, accurate pressure control, and the proper lubrication of your equipment, with a minimum amount of attention. The representative group shown is Model No. 62060-4, composed of "FLO-KLEEN" Separator, "DIATROL" Regulator, and "ATOMIZER" Lubricator. Groups featuring automatic draining or semi-automatic draining separators in combination with regulators and lubricators, are shown in New Combination Catalog No. 571. Write for your copy now.


1/8" TO 2" P.T. MODELS
GAUGE HOLE EITHER SIDE
SELF-RELIEVING TYPE
TAMPER PROOF OR REGULAR ADJUSTMENT
SITE-FLO GAUGE
TWO FILL HOLES-CAN BE FILLED WITH AIR OIL
AVILABLE AS 1-PIECE MANUAL, AUTOMATIC OR SEMI-AUTOMATIC UNIT, WITH OR WITHOUT ABSORBENT FILTER
LUBRICATES ON 1/2 CFM OR MORE
PLASTIC OR METAL BOWL
PLASTIC OR METAL BOWL
MANUAL DRAIN OR AUTOMATIC
NO AUTOMATIC SUMP HANGING BELOW-BUILT INSIDE UNIT
TAMPER PROOF OR TEE HANDLE ADJUSTMENT
PETCOCK STANDARD

Investigate Our Complete Line of Automatic Air Products. Watch for following ads featuring other units.

Find It Fast In The 'Yellow Pages'

Locate your nearest Wilkerson Distributor for more information and complete service.

WILKERSON CORPORATION

"Dedicated to keeping the NEW in pNEUmatics"

1643 W. Girard Ave., Englewood, Colo.

CIRCLE 149 ON READER SERVICE CARD

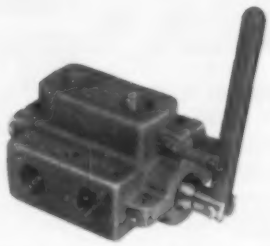
CIRCLE 57 ON READER SERVICE CARD

DOUBLE SELECTOR VALVE

GRESEN HYDRAULICS

A NEW GRESEN PRODUCT NOW AVAILABLE

Model DS-75



FEATURES: Cast iron body—pressure balanced spool—Easy to mount—Chrome plated spool—Optional three handle positions.

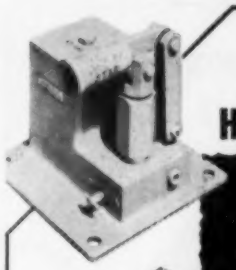
SPECIFICATIONS: Capacity—24GPM @15 ft/sec.
Pressure range—0 to 1500 PSI
All openings—¾" NPT
Shipping weight—12 lbs.

Write for literature

GRESEN MANUFACTURING CO.

405-35 Ave. N. E. Dept. AH-48 Minneapolis 18, Minn.

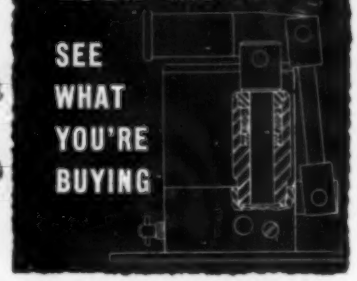
CIRCLE 127 ON READER SERVICE CARD



STAR
SINGLE PISTON
HYDRAULIC PUMP

LOOK INSIDE—

SEE WHAT YOU'RE BUYING

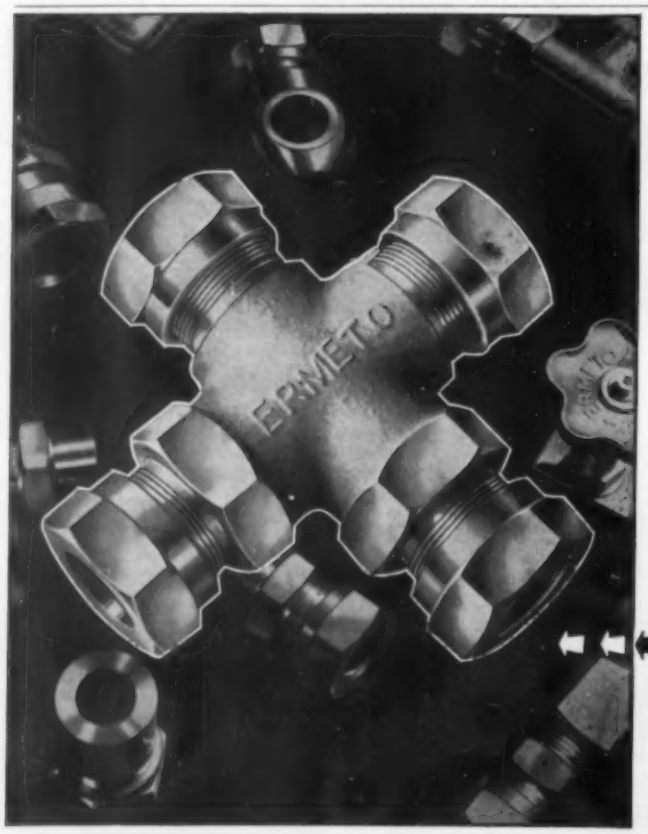


- Spring loaded multiple chevron piston packings for lifelong service.
- All pistons chromium-plated to guard against abrasions.
- SAFETY BY-PASS VALVE to prevent overload dangers.
- Gauge opening.
- 60 cu. in. reservoir or smaller or larger to specifications.
- ½", ¾" or 1" pistons with 1½" stroke.
- 24" or 30" levers, as desired.

Ask for catalog #555. Special engineering counsel cheerfully submitted on request.

Representative areas available.

STAR JACK CO., INC.
420 LEXINGTON AVE., DEPT. AH, N.Y.C. 17
PLANT: RIVER GROVE, ILLINOIS



Internationally Recognised

ERMETO fittings are the internationally recognised method of coupling high pressure pipe lines. Enormous numbers are in use throughout the world.
Supplied in mild steel, stainless steel, brass, bronze and aluminium for all pipe sizes, standard and non-standard up to 2" o.d.

A wide range of valves also available.
Catalogues on request.

ERMETO

BRITISH ERMETO CORPORATION LTD
Beacon Works, Hargrave Road, Maidenhead
Tel: Maidenhead 2271-4

CIRCLE 26 ON READER SERVICE CARD

NEW PRODUCTS

metering and is connected to the air motor piston with ball and socket couplings.

Specifications: Valve will regulate flows from a few drops to 100 gpm using 3 to 15 psi. air pressure.

United Hydraulics, Inc.
Dayton Ohio

CIRCLE 313 ON READER SERVICE CARD

AIR LUBRICATOR

. . . doesn't waste oil

Designation: Pneu-Liner

Features: Designed for applications where adjustments must hold for a

long time. Lubricator has a clear plastic dome on top which permits a view of its operation.

Specifications: The ½-in. size will lubricate up to 90 cfm of air.

Gits Bros. Mfg. Co.
Chicago, Ill.

CIRCLE 314 ON READER SERVICE CARD

HYDRAULIC BLEEDER VALVE

. . . has rotating port

Features: Valve is compact and bleeds air from hydraulic circuits.

It has a discharge port that can be rotated 360 degrees for bleeding in confined areas.

Continued on page 148

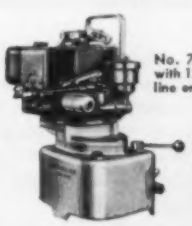
Up to 10,000 psi,
6,000 psi continuous

No. 798-AC Power Pump with ¾-hp, 115-230-volt a-c electric motor

TWO SPEEDS FOR FAST RAM APPROACH!

GREENLEE NO. 798 Portable Power Pumps eliminate nearly all the time loss accumulating while operators of hydraulic devices wait for the ram to contact the work! If you specify pumps for hydraulic rams, jacks, presses, or other systems, be sure to learn the details of this *exclusive* advantage and numerous other advance features of GREENLEE No. 798 Power Pumps capable of developing continuous pressure of 6,000 psi and up to 10,000 psi intermittent pressure. Delivery rate at 1,000 psi, 36 cubic inches per minute; at 10,000 psi, 28 cubic inches. Available with 115-230-volt a-c or 115-volt ac-dc motor; also with gasoline engine. All deliver fast dependable hydraulic power with superior efficiency.

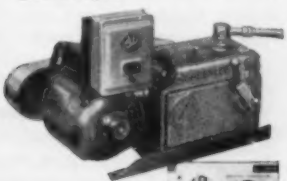
Fast hydraulic return of ram is available in every type GREENLEE Power Pump! All pumps available for *either* single-action or two-way-action rams.



No. 798-GM—with 1.7-hp gasoline engine

No. 798-CO—with ½-hp, 115-volt ac-dc universal electric motor

No. 797-E—with choice of 2-hp or 3-hp a-c electric motor, delivering 106 or 213 cu in. of oil per min. Also available with gasoline engine.



TOOLS FOR CRAFTSMEN
GREENLEE

WRITE, or simply attach this page to your letterhead, for illustrated data sheets giving applications, features, and specifications of GREENLEE No. 798 Pumps.

GREENLEE TOOL CO., 2444 HERBERT AVE., ROCKFORD, ILLINOIS, U.S.A.

O-M Cylinders give power new dimensions in close quarters

Compared with cylinders of conventional design, having the same size bore, and activated by the same operating pressure, O-M's original Internal Key-type Cylinders develop more power in ⅓ less space on both air and hydraulic circuits.

These compact, powerful components, that fit where others won't, are ruggedly constructed to stand up under protracted service within a wide range of operating pressures. The O-M Internal Locking Key simplifies disassembly, inspection, and service with no alignment problems in reassembly. Besides, the ports can be oriented to any position.

The unique O-M design also assures maximum versatility. By using a majority of standard parts, you get the advantage of "special" cylinders designed to do your job better at a very nominal cost over standard cylinders. These and other engineering advantages and economies of O-M Internal Key-type Cylinders suggest uses in a wide variety of original equipment.

O-M Internal Key-type Air and Hydraulic Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

Mail Coupon TODAY *for Bulletins 101A (O-M Internal Key-type Air and Hydraulic Cylinders), and 105 (O-M Series T-H Heavy-duty Hydraulic Cylinders).*

ORTMAN-MILLER MACHINE CO

1 143rd Street, Hammond, Indiana

☐ Have representative call

☐ Send Bulletins 101A and 105

Name_____ Position_____

Company_____

Address_____

City_____ Zone_____ State_____

NEW PRODUCTS

Specifications: Valve is made of cadmium plated steel with 3/16-in. OD nozzle and 5/16-in. 24 UNF Thread. Operating pressure is 3500 psi.

Fluid Regulators Inc.
Painesville, Ohio

CIRCLE 315 ON READER SERVICE CARD

AIR EXHAUST SILENCER

. . . has low back pressure

Designation: Muffl-Maze

Features: Silencer is a compact self-contained unit that mounts on any discharge port or piping with standard pipe threads. It contains a galvanized wire media that can be cleaned in any solvent. Backpressure on the ½-in. size when passing 15 cfm is only 16 inches of water. They are available in sizes from ⅛-in. to ¾-in. pipe.

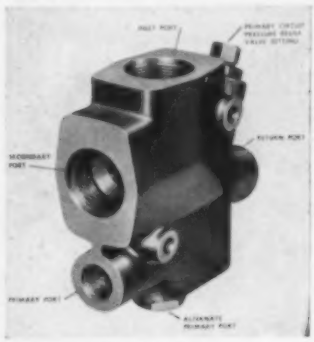
Air-Maze Corporation
Cleveland, Ohio

CIRCLE 316 ON READER SERVICE CARD

FLOW DIVIDER

. . . has high capacity

Features: This 60-gpm flow divider was designed to eliminate the need for a second pump. It supplies two circuits such as power lift and



power steering from one pump. It also allows two operations at different pressures from one pump.

The divider is factory set to allow a constant flow to the secondary circuit. This flow will not vary with pump speed. Valve will operate at 2000 psi and has a built-in relief valve on the secondary circuit.

Webster Electric Co.
Racine, Wis.

CIRCLE 317 ON READER SERVICE CARD

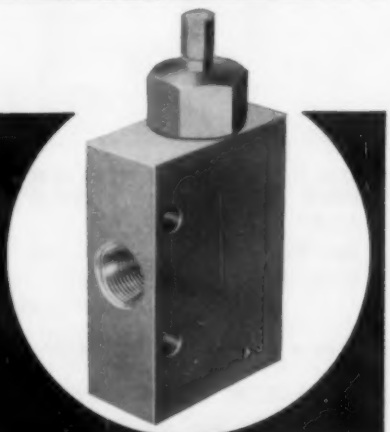
Continued on page 151

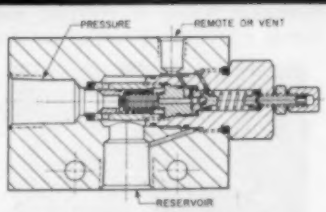
NEW! High Capacity

Remotely Operated RELIEF VALVE

. . . maintains constant relief pressure

. . . saves money





- Cracking pressure is 90% or more of maximum relief pressure.
- Closely controlled pressure characteristics permit design of other parts of circuit to close limits.
- Long life.
- Economical.

• For Oil • Pressure — 3,000 psi • ½", ¾" and 1" pipe sizes.

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

Fluid Controls, inc.

1284 N. CENTER STREET • MENTOR, OHIO

Member of Fluid Power Association

CIRCLE 98 ON READER SERVICE CARD

CIRCLE 45 ON READER SERVICE CARD

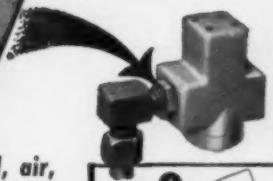
CIRCLE 135 ON READER SERVICE CARD

TRU-SEAL

TEFLON SEAL

PAT. PENDING

Saves hours in piping installations



Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

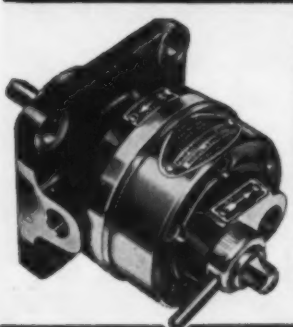
For further information write

TRU-SEAL DIVISION
FLICK-REEDY CORPORATION
2008 N. Hawthorne, Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

1
Thread Tru-Seal on pipe or fitting as far as it will go hand tight.
SEAL SIDE
2
Thread pipe or fitting 3 threads into port. Point in desired direction.
3
Tighten Tru-Seal to complete leakproof assembly (only light torque required).

SAVERY ANNULAR PISTON PUMP



Infinitely variable from maximum output down to zero. Working pressures up to 1500 p.s.i. Fixed delivery models also available.

This compact rotary pump without Gears, Valves, Vanes or Springs is of unique design and simple in construction.

The pump has the following desirable characteristics:

- Volumetric efficiency as high as 99%
- Absolute positive action and steady uniform flow at slow speeds
- No aeration or turbulence of the fluid
- The path of the fluid through the pump is unidirectional and the internals are constantly swept by the fluid
- No idle pockets or passages to cause air locks or allow coagulation
- Completely self-lubricating, ensuring capacity to run for long periods without attention
- Leakproof

U. S. and CANADIAN AGENT
DAVIES BROS., GLADSTONE, NEW JERSEY

Thomas Savery Pumps Ltd., Birmingham, England

CIRCLE 91 ON READER SERVICE CARD

GREATER PROTECTION to your AIR LINE!

M-B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)

SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

M-B PRODUCTS
46 VICTOR AVE., Div. 18
DETROIT 3, MICHIGAN

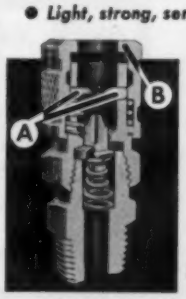
Visit our Booth 1459 ASTE Show

Extra Safety...Fast!

simple twist locks John Henry Couplers

***NOW*... a quick detachable coupler or permanent connection**

- *Twist sleeve to lock... reverse twist to unlock.*
- *Light, strong, semi-automatic... for air, oil or grease lines.*



Use direct to reciprocating tools, John Henry Couplers need no lead hoses. Specially designed dogs (A) hold tighter, grip 41% of locking surface. Extra safety—will not disconnect in locked position.

Easy to replace parts . . . change valve, spring or washer without special tools. Front flange (B) on chrome sleeve eliminates usual wear at front . . . increases strength 150%. Plug swivels freely.

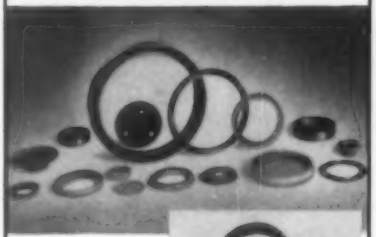
NEW FREE CATALOG... write today
Gives complete specifications for John Henry, Foster-Matic and Foster ball-type couplers.

FOSTER MFG. CO., INC.
2850 Gravois, Dept. 13-C, St. Louis 18, Mo.

For Efficiency & Long Life

GRATON AND KNIGHT®

MECHANICAL PACKINGS



LEATHER

SYNTHETIC

"O" RINGS

CUP

FLANGE

"U"

"V"

WASHERS

"O" RINGS

Looking for packings that have proven their ability to withstand high pressures and severe operating conditions? G&K offers you just such packings in their complete line of leather, synthetic and "O" rings. You can be sure that the packings G&K engineers recommend will do the job better and last longer.

Remember G&K . . . world's largest manufacturer of industrial leathers were pioneers in the manufacture of mechanical leather packings and are equipped to solve your packing problems . . . For service and quality you can count on G&K.

Write today for detailed information on G&K packings

GRATON & KNIGHT Company INC.

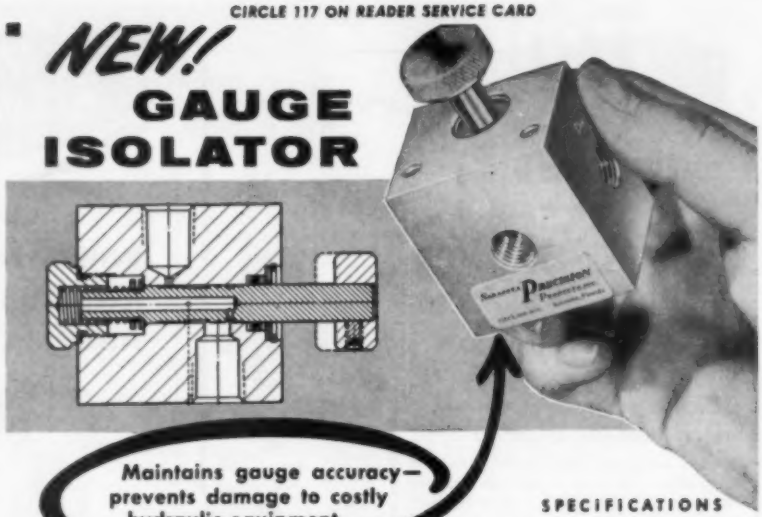
WORCESTER 4, MASSACHUSETTS

CIRCLE 54 ON READER SERVICE CARD

CIRCLE 117 ON READER SERVICE CARD

NEW!

GAUGE ISOLATOR



Maintains gauge accuracy—prevents damage to costly hydraulic equipment.

■ Included in any hydraulic circuit, the new SARASOTA GAUGE ISOLATOR prevents gauge damage due to surge pressure. By maintaining correct pressure with accurate gauges, damage to hydraulic components, molds, dies, etc. is prevented. The unit is normally closed, preventing flow to the gauge. Depressing the push-button opens the gauge line to permit reading. Releasing the push-button closes the gauge line and drains the gauge to the reservoir.

SPECIFICATIONS

For hydraulic oil and many other fluids.

- 5000 psi. operating pressure — 7500 psi. proof.
- ¼" N.P.T.F. ports standard.

LIST PRICE

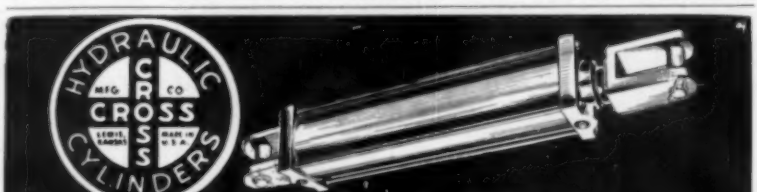
$14.85 F.O.B. Sarasota, Florida.

Send purchase orders or inquiries to:

Designers and Manufacturers of Hydraulic Valves & Devices

SARASOTA Precision products inc.

1314 N. LIME AVENUE • SARASOTA, FLORIDA ■



HYDRAULIC CYLINDERS — CROSS MFG. CO.

RUGGED ECONOMICAL DEPENDABLE

THE MOST REASONABLY PRICED ENGINEERED QUALITY CYLINDERS AVAILABLE

HYDRAULIC CYLINDERS — CROSS MFG. CO.

CROSS MANUFACTURING CO.

LEWIS, KANSAS ■ PHONE EA 4-5525

WRITE • WIRE • PHONE

CIRCLE 36 ON READER SERVICE CARD

NEW PRODUCTS

HYDROSTATIC TESTER
. . . is a portable unit

Designation: HydroKit

Features: Tester is portable (weighs 17 lbs.) and has a 3000-psi hand pump, pressure gauge, and reservoir. It also contains a pressure connection for permanent piping.

Specifications: Models available with pressure gauges from 500 to 3000-psi.

Farris Engineering Corp.
Palisades Park, N. J.

CIRCLE 318 ON READER SERVICE CARD

DIRECTIONAL VALVES
. . . with oil immersed solenoid

Features: These 2 and 4-way directional control valves are made with oil-immersed solenoids that increase service life 20 to 30 times. The solenoids have a plug-in type connector for quick installation.

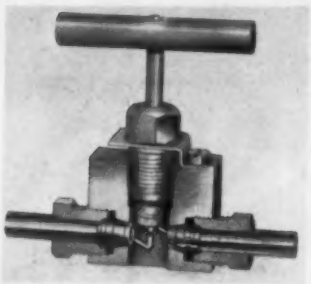
The valves are available in spring-centered, spring-offset, and no-spring models. Seven spool types meet all circuit needs. Mounting can be with gasket or sub-plate.

Valves are for heavy duty, continuous, high cycling operation at pressures to 3000 psi.

Vickers Incorporated
Detroit, Mich.

CIRCLE 319 ON READER SERVICE CARD

STAINLESS STEEL VALVES
. . . for 10,000 psi service



Features: Designed for perfect seating. Valve body machined to accept Ermeto nuts for quick tubing connections. Ermeto nut presses on the bevel of the sleeve causing it to clamp tightly to the tube. When fully tightened the case hardened sleeve is bowed slightly at the midsection and acts as a spring. This action prevents the nut from loosening. A locking device is provided for the packing nut.

American Instrument Co.
Silver Spring, Maryland

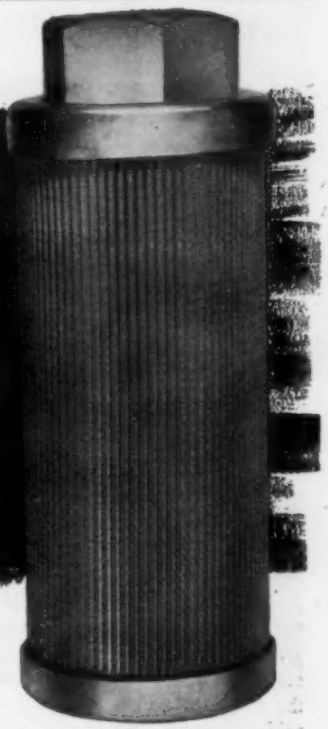
CIRCLE 320 ON READER SERVICE CARD

Continued on page 152

Capital

HYDRAULIC OIL FILTER
with
Monel Metal Insert

Reservoir Type for Hydraulic and Oil Re-circulating Machinery



EASY TO INSTALL—EASY TO CLEAN
LONG LIFE—LOW COST—SIZES AND SCREENS TO FIT YOUR NEEDS

★ ONLY THREE PARTS
★ MEETS J.I.C. STANDARDS
★ GREATER FILTERING AREA
★ SPECIAL TRAP-WEAVE MESH

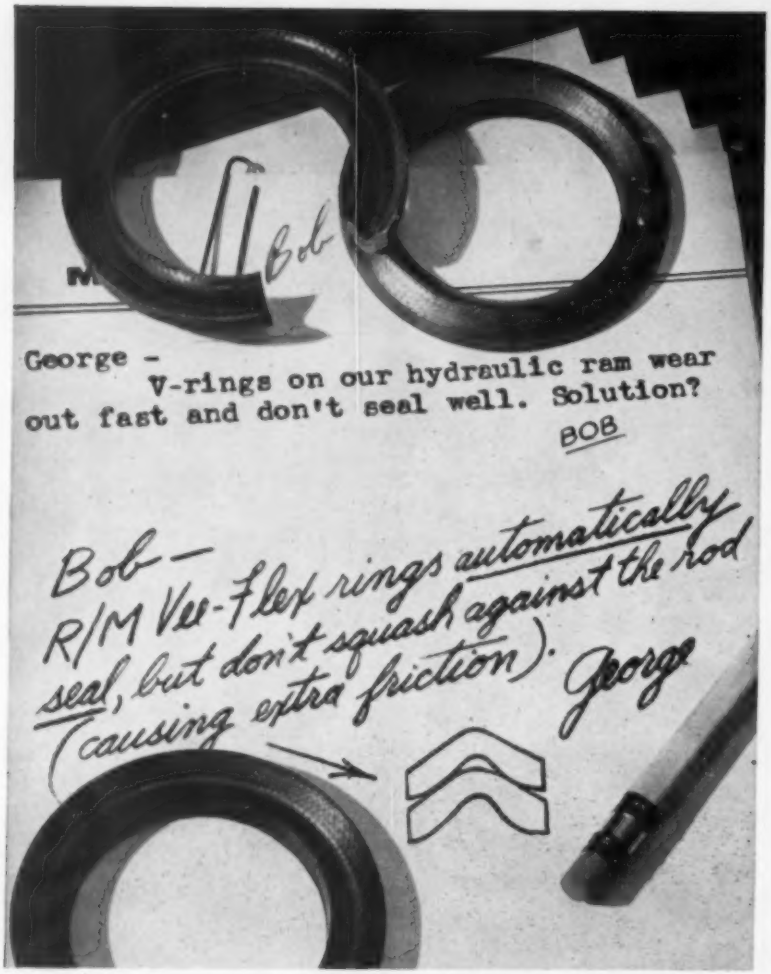
Specially woven MONEL wire cloth and a new method of compact corrugation, gives triple protection with less space than other filters of like capacity. Trap-weave mesh stops thin, elongated particles with NO loss of efficiency.

Non-corrosive, non-toxic materials throughout. Easily cleaned with an ordinary brush.

Write for descriptive circular.

CAPITAL ENGINEERING & MFG. CORP.
6836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

CIRCLE 28 ON READER SERVICE CARD


George -
V-rings on our hydraulic ram wear out fast and don't seal well. Solution?
BOB
Bob—
R/M Vee-Flex rings automatically seal, but don't squash against the rod (causing extra friction). George

Raybestos-Manhattan Vee-Flex® Rings cut your maintenance problems and give you better performance. Convex curvature of the surface which touches the next ring makes them self-sealing, self-adjusting. Hydraulic pressure stroke produces seal against stuffing box wall and against adjacent ring.

Not only better design, but also better construction. Fabric is deeply penetrated by compound to provide longer, more dependable wear. Precision molding and trimming for the best possible fit and extra-long service life.

Use R/M Vee-Flex Rings on hydraulic rams, steam or air rods, hot oil pumps, outside-packed plunger pumps, food handling machinery or accumulator and elevator rams on oil or water service.

R/M engineers have amassed a wealth of experience in manufacturing packings and gasket materials to satisfy the most exacting requirements of industry. This experience is at your disposal—call on R/M!

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS—including Vee-Flex, Vee-Square, Universal Plastic, and "versi-pak"*; GASKET MATERIALS; "TEFLON"* PRODUCTS. SEE YOUR R/M DISTRIBUTOR
*A Du Pont trademark

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

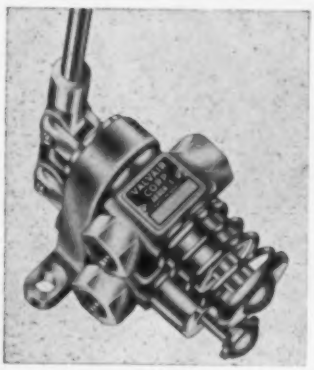
RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings Brake Blocks • Clutch Facings • Industrial Adhesives • Bowling Balls • Laundry Pads and Covers

NEW PRODUCTS

AIR CONTROL VALVES

. . . are tandem mounted

Features: Valves are lever-operated, 3 and 4-way. Tandem mounting permits combining a variety of basic valves. Either manual or spring-loaded neutral positioning is available. The tandem valve is



interlocked to prevent both valves operating at the same time. Flow area through the valves is equal to nominal pipe size.

Specifications: Valves are for 250-psi air and 325-psi oil or vacuum service in ¼ to 1-in. NPT.

Valvair Corporation
Akron, Ohio

CIRCLE 321 ON READER SERVICE CARD

FLOW CONTROL VALVE

. . . compensates for temperature

Features: Valve is for 2000-psi service and is not effected by changes in temperature or viscosity.

It is available with built-in check and or relief valve and is designed to meet JIC standards. It has two elements, (1) A pressure compen-

CIRCLE 108 ON READER SERVICE CARD

sator responsive to both inlet and outlet pressure. This maintains a constant differential with the pressure in the outlet port. (2) An adjustable orifice between the differential pressure area and the outlet port.

Specifications: Valve is available in ¼", ⅜", and ¾" port sizes and has flow ranges from 5 cu. in./min. to 28 gpm.

Denison Engineering Div.
American Brake Shoe Co.
Columbus, Ohio

CIRCLE 322 ON READER SERVICE CARD

AIR FILTER
. . . is nickel-plated brass

Features: This single-tube filter for air is made from nickle-plated brass to eliminate rusting. A 7-in. honeycomb filter tube gives depth

filtration and aids removal of moisture, dirt, and oil. To replace the element, only the top nut must be removed. Filter tubes can be furnished in a wide range of densities.

Commercial Filters Corp.
Melrose, Mass.

CIRCLE 323 ON READER SERVICE CARD

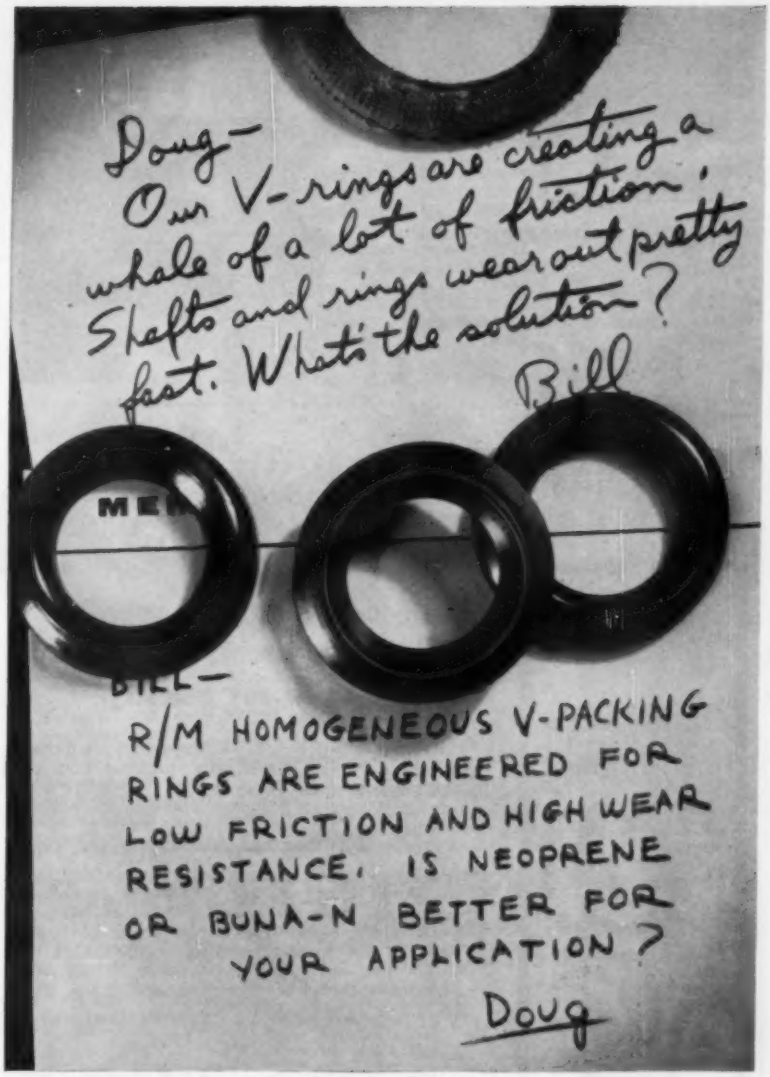
10,000 PSI POWER UNIT
. . . is portable

Specifications: Pump is rated for 10,000 psi intermittent and 5000 psi continuous duty, delivering 80 cubic inches per minute. The pump is driven by a ½ hp single phase, 60 cycle, 1750 rpm, 110-220 volt motor. Entire assembly weighs 65 pounds.

Tal Bending Equipment, Inc.
Milwaukee, Wisconsin

CIRCLE 324 ON READER SERVICE CARD

Continued on page 154


Doug—
Our V-rings are creating a whale of a lot of friction. Shafts and rings wear out pretty fast. What's the solution?
Bill
BILL—
R/M HOMOGENEOUS V-PACKING RINGS ARE ENGINEERED FOR LOW FRICTION AND HIGH WEAR RESISTANCE. IS NEOPRENE OR BUNA-N BETTER FOR YOUR APPLICATION?
Doug

Homogeneous V-packing rings by R/M are engineered and precision molded to give you your best solution to many touchy problems. With a Neoprene base, they provide you with low friction, low swelling, and high wear-resisting characteristics. Buna-N based R/M V-rings offer, in addition, exceptionally high oil resistance.

Whichever type is best for your particular applications, you can be sure that V-rings molded by R/M meet the most exacting dimensional requirements. They are cleanly, sharply molded to precision tolerances. Available in sizes from ⅛ to 15 in. ID.

R/M's engineers have amassed a wealth of experience in manufacturing packings and gasket materials to meet the most exacting requirements of industry. This experience is at your disposal—call on R/M!

R/M's complete line of mechanical packings includes Vee-Flex® and Vee-Square® Packings, Homogeneous V-Rings, and Fabric Piston Cups. Write for complete information.

R/M
PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics
Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings
Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

CIRCLE 109 ON READER SERVICE CARD

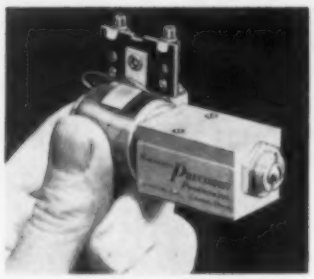
NEW PRODUCTS

SOLENOID VALVE

. . . weighs 4½ ounces

Features: Designed for pilot operation of larger valves, this valve can also be used as a direct acting on-off valve in small hydraulic systems. When two or more are mounted on a sub-plate, they can be used as 3 or 4-way valves.

Specifications: Valve available for 6 to 48-volt dc and 110-volt ac operation and is designed for 3000-psi service. Valve will deliver 17 cu. in./min. at 100-psi pressure drop.



Sarasota Precision Products, Inc.
Sarasota, Florida

CIRCLE 325 ON READER SERVICE CARD

RECTANGULAR SEAL RINGS

. . . lathe-cut to close tolerance

Features: These rings are made in all compounds in which standard O-rings are molded. A new process produces flat rings economically within closer tolerances than ordinary lathe cutting. This makes the rings suitable for many gasket applications.

Parker-Hannifin Corp.
Cleveland, Ohio

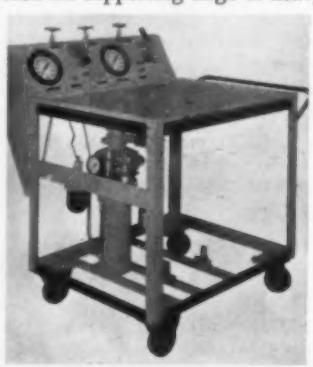
CIRCLE 326 ON READER SERVICE CARD

PORTABLE TEST STAND

. . . for hydraulics

Designation: KC-854

Features: Entire stand is mounted on a portable, welded steel cart. A large 750 square inch tray is provided for supporting large or heavy components. The unit requires only shop air for operation. Individual units provide maximum pressures from 3000 to 30,000 psi. The unit may be used safely in hazardous areas.



Kahn and Company, Inc.
Hartford, Connecticut

CIRCLE 327 ON READER SERVICE CARD

BHEW Custom-Built **HYDRAULIC CYLINDERS**

Made-to-order to meet specific design requirements for any application in any industry.

Compactness! Efficiency! Close Tolerances! Outstanding operational performance! You get them all in BHEW cylinders. They require minimum mounting space. There is no tooling charge for BHEW cylinders, built to meet *your* specifications and delivered on schedule.

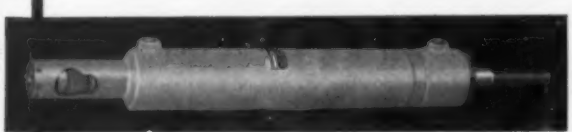
BHEW cylinders are available in standard and special O.E.M. designs . . . single or double acting and telescopic; 1½" to 8" bore; strokes up to 156"; oil hydraulic service in 1,500 psi or 3,000 psi working pressure, pneumatic up to 150 psi; cup-type, ring-type or O-ring construction; choice of mounting.

1 Cylinder barrel and non-adjustable gland welded into one piece, eliminates joint, makes small O.D. in large single and double-acting hoist cylinders.

2 Accurately honed barrel.

3 Hard chrome-plated rod.

4 Flow regulating or pilot operative check valve in base, when required.

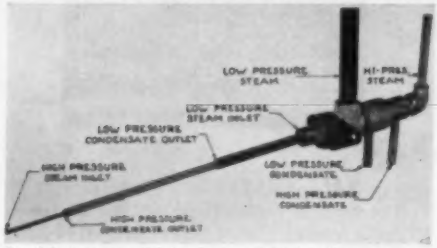


WRITE *for your copy of Hydraulic Cylinder Engineering Reference Data Manual.* Can save you hours of time in specifying cylinders. 40 dimensioned basic designs for general and special purpose double acting cylinders.

BHEW Benton Harbor Engineering Works, Inc.
622 Langley Avenue, St. Joseph, Michigan

CIRCLE 24 ON READER SERVICE CARD

CIRCLE 115 ON READER SERVICE CARD



Special 4-passage joint solves a fluid handling problem.

PRECISION • QUALITY • CONCENTRICITY

BUILT INTO Rotherm

REVOLVING JOINTS ASSURE EFFICIENCY IN OPERATION

We are specialists in the design and manufacture of revolving joints for fluids, gases and vacuum. Send us your design requirements for revolving joints. Learn how multi-passage joints can simplify design.

Temperature Range —65 to +500°

See us at the Design Show— Booth 1023

Self-Aligning joint

Write for our expansion joint catalogue

Rotherm Engineering Co., Inc.

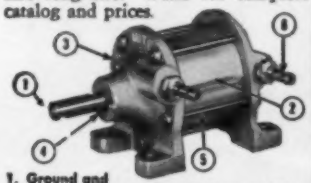
7280 W. DEVON AVE. • CHICAGO 31, ILLINOIS

CIRCLE 5 ON READER SERVICE CARD

AIR-MITE AIR CYLINDERS

Low Cost...Compact...Powerful...Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.



1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types

AIR-MITE Devices, Inc.

4401 W. KINZIE • CHICAGO, ILLINOIS

Hydraulic's House of Ideas in Control Engineering

HUSCO of WAUKESHA

For New Ideas in Hydraulic Control Engineering Fill Out Coupon Creative engineering in hydraulic control is probably the most important part of HUSCO's service to industry. Each HUSCO control is designed to solve a specific problem in application, by experts of wide experience. For this reason HUSCO engineers welcome the challenge of new and difficult control demands. The growing list of satisfied customers is confirmation of their success in meeting these demands.

HUSCO

HYDRAULIC UNIT SPECIALTIES CO.

Pumps • Valves • Cylinders

Waukesha, Wisconsin

In the fast-moving Hydraulics industry, it is inevitable that a high premium be placed on new ideas, in every phase of design, engineering, application and production of new hydraulic control equipment.

This fact is confirmed at HUSCO. For over a decade Husco has contributed a wealth of new developments in fluid controls, valves, pumps and cylinders. Sparking new circuits and truly dependable controls for hydraulically operated equipment in such widely varying fields as construction, materials handling and transportation.

HYDRAULIC UNIT SPECIALTIES CO.

P. O. Box 257-A

Waukesha, Wisconsin

For new ideas in Hydraulic Control Engineering, fill out this coupon. We will send quotes, prints and specifications upon request at no obligation.

1. Type and number of operating plungers required.———
2. Size of pump in G.P.M.———
3. Operating pressure in P.S.I.———
4. Type of equipment———
5. Sketch or print if possible on proposed application. Coming ☐ Not available ☐
6. We will send a representative upon request. Send a representative—at once ☐ 2 weeks ☐ we will advise ☐

NAME .....

ADDRESS .....

CITY ..... State.....

INDIVIDUAL .....

STRATOFLEX

Quality Control

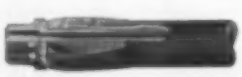
Pressure testing hose and fitting assemblies at Stratoflex plant.

Your Assurance of that EXTRA Measure of Dependability in flexible Hose and Fittings

For dependable, trouble-free hydraulic and other high pressure fluid lines, specify Stratoflex hose and reusable fittings. Stratoflex hose and fittings are performance proved by the most advanced testing equipment available – your assurance of consistent high quality.

211—Medium pressure single wire braid hose. Temperature range: —40 to +275°F.

212—High pressure double wire braid hose. Temperature range: —40 to +200°F.



225—Medium pressure single wire braid hose. Temperature range: —40 to +200°F.

224—Medium pressure stainless steel wire braid cover and innertube. Weather resistant, non-inflammable. Temperature range: —65 to +450°F.

Call your industrial supply store or write for complete catalog.

STRATOFLEX Inc.

P.O. Box 10398 • Fort Worth, Texas

Branch Plants: Los Angeles, Fort Wayne, Toronto

In Canada: Stratoflex of Canada, Inc.

SALES OFFICES: Atlanta, Chicago, Dayton, Detroit, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Toronto, Tulsa

USEFUL LITERATURE

BALL VALVES . . . in ½ to 8-in. sizes are illustrated in a bulletin prepared by *Jamesbury Corp., Worcester, Mass.* It has a tabulation of parts and dimensions on the entire series of double-seal, flanged valves. Features are unit-body construction, positive shut-off, low torque, and replaceable seats and seals. High flow rates are possible with the ball type construction.

CIRCLE 410 ON READER SERVICE CARD

FLOW RATE ALARMS . . . for signalling or simple control functions are shown in Bulletin 165 of the *Brooks Rotameter Co., Lansdale, Pa.* Specifications and operating details are given on both magnetic and electronic sensing units. Units described feature a fail-safe circuit design and sufficient accuracy to detect as little as one millimeter of rotameter float movement.

CIRCLE 411 ON READER SERVICE CARD

TUBING TOLERANCES . . . are available on a card, TDC-115D printed by the *Tubular Products Div., Babcock and Wilcox Co., Beaver Falls, Pa.* The data card covers dimensional tolerances of cold drawn and hot-finished tubing. It was prepared from information contained in the Steel Tubular Products Section of the AISI Steel Products Manual.

CIRCLE 412 ON READER SERVICE CARD

FLEXIBLE METAL HOSE . . . made in bronze, brass, steel, stainless steel, and monel is described and illustrated in a 60-page catalogue issued by *The American Brass Co., American Metal Hose Div., Waterbury, Conn.* Hose assemblies can be furnished with pipe or SAE threaded fittings and have burst pressures to 11,000 psi. The catalog has engineering specifications on Teflon hose.

CIRCLE 413 ON READER SERVICE CARD

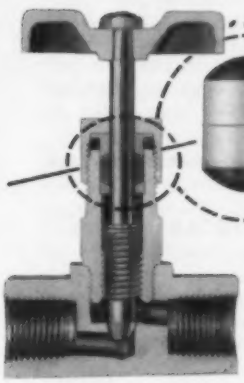
AUTOMATIC VALVES . . . for air and water service are described and illustrated in a 4-page bulletin issued by *A. W. Cash Valve Mfg. Corp., Decatur, Ill.* It features quick-reference data on their pressure reducing and regulating valves,

Continued on page 158

CIRCLE 90 ON READER SERVICE CARD

"...yet we have IMPROVED it"

The Marsh Stainless Steel Needle Valve could have gone right on being the finest in its field...yet we have improved it



...with fabulous "TEFLON" packing

Note the "close-up." The Marsh Marpak packing system, originated in the Marsh Needle Valve, was one of the factors that has enabled it to stand up and work right under pressures up to 10,000 psi.

Now "Teflon" is used in this packing system—the miracle material of almost incredible *toughness*, *resilience* and *non-adhesive* properties...properties that are not impaired by the most powerful of solvents, acids, or alkalies even at temperatures *up to 500° F.*

Net result: The guaranteed application-range (up to 10,000 psi) is now effective at any temperature up to 500° F. (In other makes, permissible temperature decreases as pressure increases.)

Marsh Marpak Teflon Packing System is standard in Marsh 416 Stainless Steel Needle Throttling Valves. Ask for facts.

MARSH

Needle Valve in 416

stainless steel throughout

Now with "Teflon" Packing

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.*, Dept. 19, Skokie, Ill.

Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta

Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

CIRCLE 14 ON READER SERVICE CARD

Armite

LED-PLATE

ANTI-SEIZE SEALING COMPOUND

The Thread Lubricant and Sealant for PIPE ★ BOLTS ★ STUDS

Approved and used by leading manufacturers of aircraft and industrial hydraulic and pneumatic equipment.—Ends leakage—Won't "ball up"—Will not plug orifices or filters—Easy disassembly.

A REAL THREAD SEALER
Pressures held to 50,000 psi hydraulic fluids, 3500 psi air, 1000 psi gases. Use for: hydraulic fluids, gases, steam, ammonia, air, acids, fuels, water, etc.

NO HEAT FREEZE
Temperature range: minus 350° to plus 2987° F.

NO CORROSION WELD
Prevents rusting, acid-etch and corrosion.

NO GALLING OR SEIZING
Recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.

EASY ASSEMBLY-DISASSEMBLY
Fast, easy, anytime. Low torque. No seize.

GOVERNMENT SPECIFICATIONS
met as an anti-seize for high temperatures.

Approved for:
Butane
Propane
Gasoline
Petroleum oils

Send for YOUR FREE SAMPLE

ARMITE LABORATORIES
6609 BROAD STREET
LOS ANGELES 1, CALIF., U.S.A.

"Wipe out" PACKING FAILURES WITH Seal-Guard METALLIC ROD WIPERS

Self-adjusting, easy to install, Seal-Guard's knife-like bronze rings "wipe off" all dirt and grime, will not mar the rod, are oil and heat resistant and friction-free.

HOW SEAL-GUARD WORKS

1. Twin wiper rings are mounted on rod with notches staggered.
2. Cushion ring is compressed on assembly exerting constant inward pressure keeping ring in constant contact with rod.
3. Harmful substances are completely cleared by scraper action.

Seal-Guards are available to fit rod diameters from ¼ to 24 inches. Other sizes by special order.

WRITE FOR DESCRIPTIVE LITERATURE.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Rd. Van Dyke, Mich.

"ADJUSTABLE STROKE" MIDGET Air-Clamp* CYLINDER

*TRADEMARK

Now—put pressure where it's wanted instantly and cheaply, with Mead's powerful new midget air cylinders (1" bore, single-acting, spring return—horizontal and vertical). Stroke is adjustable. Cut costs—use 'em singly or in groups to move, hold, press or eject small work pieces; to close and open large jigs, forms, fixtures. They'll replace human fingers and mechanical clamps in countless routine jobs.

Catalog Free!

Write for new fact-and-picture-packed Air Power Catalog—or ask your nearest Mead Man!

MEAD
SPECIALTIES COMPANY
4114 N. Knox Ave., DEPT. AH-48
CHICAGO 41, ILLINOIS

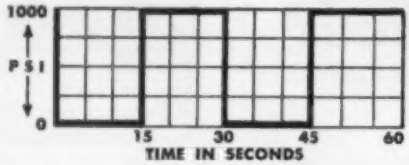
PATHFINDER IN AIR POWER AUTOMATION

CIRCLE 69 ON READER SERVICE CARD

CIRCLE 92 ON READER SERVICE CARD

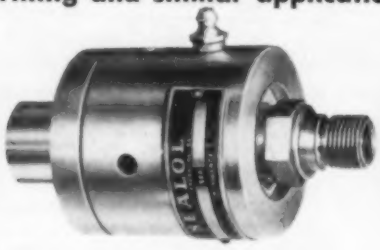
CIRCLE 119 ON READER SERVICE CARD

Built to withstand CYCLING PRESSURES 0 PSI to 1,000 PSI



for gun drilling and similar applications

CYCLING PRESSURES TO 1000 PSI



ROTATING SPEEDS TO 10,000 RPM

SEALOL TYPE EL FLUID TRANSFER

The high-pressure, high-speed Type EL Transfer is ideally suited for use with hollow shafts or spindles such as used in gun drill applications . . . with attachment made at end of spindle.

- ★ Compact . . . 3¾" OAL x 2⅛" OD
- ★ Operating Limits . . . Liquid pressures to 1000 PSIG; speeds to 10,000 RPM; temperatures to 150°F
- ★ Connections . . . ¼" — 18 NPT inlet and ⅜" — 18 NF outlet
- ★ Minimum power requirements

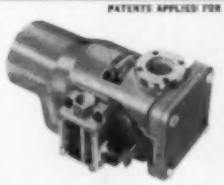
The Type EL Transfer is one of several basic Sealol types designed to meet a wide range of applications, speeds and pressures. Request bulletin for complete details.

SEALOL **SEALOL CORP**
154 Post Road
Providence 5, R. I.

PATENTS APPLIED FOR

Oil filters that tell when they're dirty . . . will never starve a pump . . . are easy to clean . . . are full flow

SEE condition of oil thru glass
FULL FLOW by-pass when filter is clogged
TELLS when to clean, by remote signal switch
EASY access to dirty cartridge



Above: 20-gpm Tell-Tale unit. Can be upped to 40 gpm with pleated filter cartridge. 50-gpm and 75-gpm Tell-Tale units (not shown) are also available.

Left: Removing the filter cartridge from a 5-gpm Tell-Tale unit. Pleated filter rating for this same unit is 10 gpm. While the optional electrical limit switch indicator is shown here, the visual indicator model is also available.

Below: 100-gpm Tell-Tale filter. Pleated filter rating is 200 gpm. All cartridges, plain or pleated, are available in five different degrees of filtration (from .0008 to .009" openings).

Rosaen Tell-Tale® units do more than filter. They indicate when the filter needs cleaning. And if ignored they by-pass oil to protect the pump (and they indicate this, too). Filters are necessary, but the high cost of filter inspection is not. Get the filter that tells when to clean, and never starves a pump. Write for more information.

The ROSAEN COMPANY
1776 EAST NINE MILE ROAD • HAZEL PARK, MICHIGAN

Dealers: Write for information

USEFUL LITERATURE

back pressure valves, and diaphragm-operated control valves. The valves are designed for inlet pressures to 400 psi and are available with iron or brass bodies and internal trim.

CIRCLE 414 ON READER SERVICE CARD

TIME CONTROLS . . . that are synchronous motor driven are covered in a catalog prepared by *Industrial Timer Corp., Newark, N. J.* It illustrates and describes their cam timers, recycling timers, and reset time totalizers. Standard units have maximum time cycles from 6 sec. to 12 hours and are ruggedly built for constant operation. They are available in both manual and automatic reset types.

CIRCLE 415 ON READER SERVICE CARD

HYDRAULIC HOSE FITTINGS . . . that are assembled without stripping the outer rubber cover are described in catalog 4440 released by *Parker Fittings and Hose Div., Parker-Hannifin Corp., Cleveland, Ohio.* The catalog lists hose and hose assemblies, and gives instructions on how to make up assemblies. It illustrates reusable connecting ends. Ends include male, pipe thread, straight thread with O-ring, 37-deg. flare end, and swivel nut to mate with flare end.

CIRCLE 416 ON READER SERVICE CARD

GAGE ISOLATOR . . . that prevents damage to pressure gages is described in a bulletin issued by *Sarasota Precision Products, Inc., Sarasota, Florida.* Isolator, S1201-2, mounted in the gage line is normally closed preventing flow to the gage. Pushing a spring-loaded button opens the line to the gage to permit reading. Releasing the button stops the flow to the gage and drains the gage line to the reservoir.

CIRCLE 417 ON READER SERVICE CARD

AIR ACTUATORS . . . with cylinder type construction for valves, pumps, and flow regulators are covered in a 12-page bulletin No. B-50-3, from *Conoflow Corp., Philadelphia, Pa.* By using instrument air to a pilot valve which controls the main valve, the actuator

will give instantaneous response and can be accurately positioned. Low pressure air is maintained on the bottom of the piston for a cushion. Booklet describes over twenty typical applications.

CIRCLE 418 ON READER SERVICE CARD

BY-PASS FLOW REGULATOR . . . with built in relief valve is described in a catalog sheet issued by *Fluid Controls, Inc., Mentor, Ohio.* The bulletin contains drawings and other engineering information. The valve combination reduces the fittings required in piping a hydraulic system. It also provides a more compact circuit by incorporating the two valves in one body.

CIRCLE 419 ON READER SERVICE CARD

FLUID POWER TRANSMISSION . . . that will vary speed ratio from 1:1 to 4000:1 is described in Bulletin 10600 issued by *The Oilgear Co., Milwaukee, Wis.* It explains the operation and characteristics of the "Any-Speed"

drives and illustrates them with performance curves and block diagrams of various applications. The 32-page booklet includes block diagrams for closed loop hydraulic feedback systems and servo-controlled, electro-hydraulic feedback drives.

CIRCLE 420 ON READER SERVICE CARD

ROTARY COMPRESSOR . . . that contains 50% fewer working parts is described and illustrated in a 4-page folder issued by *Davy Compressor Co., Kent, Ohio.* The bulletin explains operating advantages of the rotary design and how this contributes to multiple stage compression. Features include quietness and freedom from vibration. Sizes are from 20 to 40 hp at 125-psi pressure.

CIRCLE 421 ON READER SERVICE CARD

DEEP HOLE DRILLING . . . for valves, cylinders, and manifolds is performed by *Deep Hole Specialists, Inc., Chagrin Falls, Ohio* and is described in a 4-page bulletin issued by the company. The bulletin contains illustrations and information on tolerances, finish and applications. One view shows a 36-in. hole, gun-drilled through a manifold.

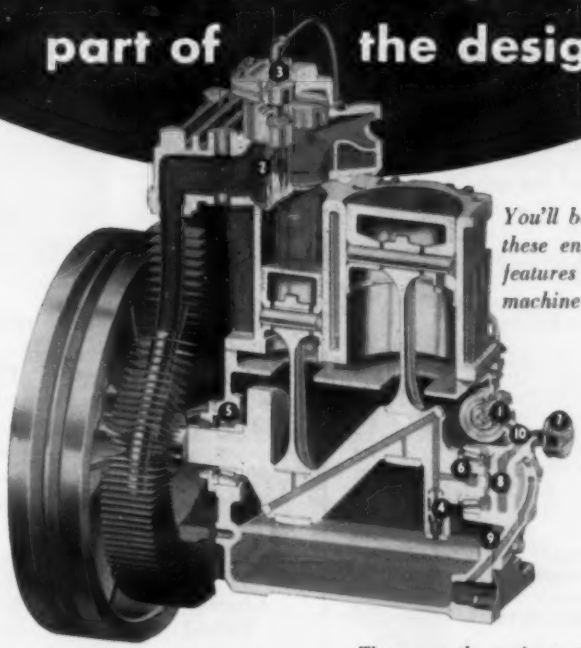
CIRCLE 422 ON READER SERVICE CARD

VIBRATION DAMPENER . . . which stabilizes rotational outputs and eliminates high frequency disturbance is described in a folder prepared by *Buffalo Hydraulics Div., Houdaille Industries, Buffalo, N. Y.* These dampeners provide smooth rapid response in the operating ranges of servo mechanisms, and reduce torsionals in rotating shafts and systems. It consists of a free, rotating inertia mass shearing a synthetic fluid contained within a sealed housing. Sizes from 1½ to 34-in. diameter.

CIRCLE 423 ON READER SERVICE CARD

WHEN COMPRESSED AIR IS PART OF THE PRODUCT

make QUINCY compressors part of the design



You'll be adding these engineering features to YOUR machine design

1. Simple hydraulic unloader valve.
2. Low-lift, high pressure intake valve.
3. Diaphragm and unloader assembly.
4. Centrifugal-closing oil spill valve in crankshaft.

5 - 6. Oversize Timken roller bearings.

7. Easy reading oil pressure gauge.
8. Discharge oil passage in bearing carrier.
9. Intake oil passage (crankcase to pump).
10. Passage to hydraulic unloader valve.

Those are the main parts of Quincy Safe-Q-Lube system—the most advanced pressure oiling and loadless starting system available in a compressor. Get full details — mail coupon today.

MAIL TODAY!

Quincy COMPRESSORS

COMPRESSOR CO.
Dept. AH-458,
Quincy, Illinois

Gentlemen: Send free catalog of industrial air compressors, and literature describing Safe-Q-Lube.

NAME
FIRM
ADDRESS
CITY ZONE STATE

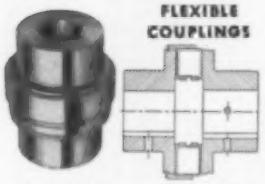
SEE THIS MODERN POWER TRANSMISSION EQUIPMENT AT THE DESIGN SHOW

Lovejoy

BOOTH 537

•

FLEXIBLE COUPLINGS

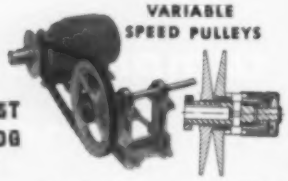


REQUEST CATALOG C-56

Bores (max.).....⅝" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 4250
Torque (static).1½ to 3100 ft.-lbs.

•

VARIABLE SPEED PULLEYS



REQUEST CATALOG P-57

Bores (max.).....½" to 1⅜"
O.D. .....3" to 13⅜"
Belt Sizes.....A to 2⅝ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.).....¼ to 15

•

UNIVERSAL JOINTS

REQUEST BULLETIN 820

Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

•

SHAFT MOUNTED GEAR REDUCERS

REQUEST CATALOG R-58

18 Models From Stock
Speeds.....8 to 425 R.P.M.
H.P. .....Fractional to 120
Ratios.....Single 4.5:1 Nominal
Double 14.7:1 Nominal
Hollow Shafts .....1⅞ to 5⅛ in.

If you can't attend, write for bulletins.

LOVEJOY FLEXIBLE COUPLING CO.

4839 W. LAKE ST. • CHICAGO 44, ILL.

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Following a recent corporate reorganization in which the firm's four subsidiaries were integrated in the parent company, **Minnesota Rubber Company,** four executives have been elected vice presidents. **Robert R. Johnson,** engineering; **E. Burke Neff,** quality and cost control; **Loren J. Sewall,** manufacturing; and **Richard G. Wells,** director of sales.

Robert R. Johnson Minnesota Rubber

Richard G. Wells Minnesota Rubber

William R. Jones, recently named product manager of soft packing for the **Garlock Packing Company,** has assumed responsibility for the marketing of the company's entire soft packing line. **E. W. Quiggle** was named product manager of the molded-extruded rubber line.

Chester W. Holmes has joined **United Aircraft Products, Inc.,** as assistant to the president. His duties will include market studies and new product investigation.

Ed Rose has been appointed sales manager of **Walter Norris Engineering Co.** in Chicago. Rose has been a sales engineer with this distributor of air and hydraulic components for the past six years.

Edward Adams, Jr. vice president of National Bank of Detroit, was elected as a member of the board of directors of **Aeroquip Corporation.**

Automatic Switch Company has appointed **Park City Supply Company,** 63 Knowlton Street, Bridgeport, Conn., as authorized stocking distributors. The company's Chicago representative **J. R. Ruddock & Associates** have moved to new offices at 4822 North Damen Avenue.

Chiksan Company, a subsidiary of Food Machinery and Chemical Corp. announced these promotions. **Louis J. Smith** to vice president and sales manager of **Chiksan Company** and **Chiksan of Canada Ltd. Edward T. Landgraff** to vice president and sales manager of **Chiksan Export Company. John F. Powers** succeeds L. J. Smith as eastern regional sales manager.

Louis J. Smith Chiksan Co.

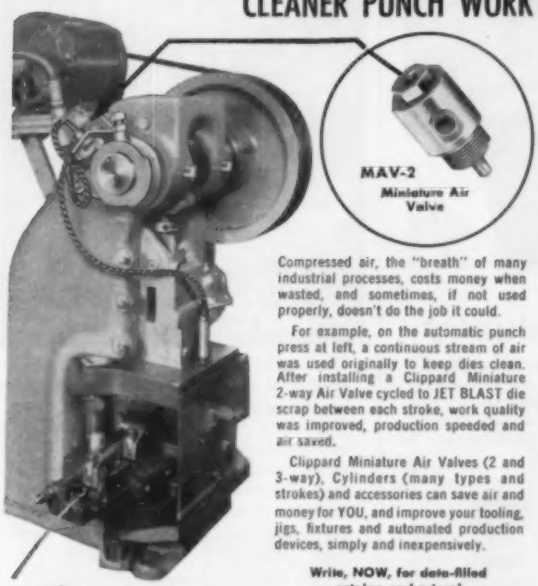
E. T. Landgraff Chiksan Co.

Miller Fluid Power Division, Flick-Reedy Corp. have promoted **James Schaeffer** to assistant to the production manager. Schaeffer, who has been with the company since 1956, has been working in the production control department.

Continued on page 163

CIRCLE 31 ON READER SERVICE CARD

How to SAVE Your BREATH, MONEY, and do CLEANER PUNCH WORK!



Compressed air, the "breath" of many industrial processes, costs money when wasted, and sometimes, if not used properly, doesn't do the job it could.

For example, on the automatic punch press at left, a continuous stream of air was used originally to keep dies clean. After installing a Clippard Miniature 2-way Air Valve cycled to JET BLAST die scrap between each stroke, work quality was improved, production speeded and air saved.

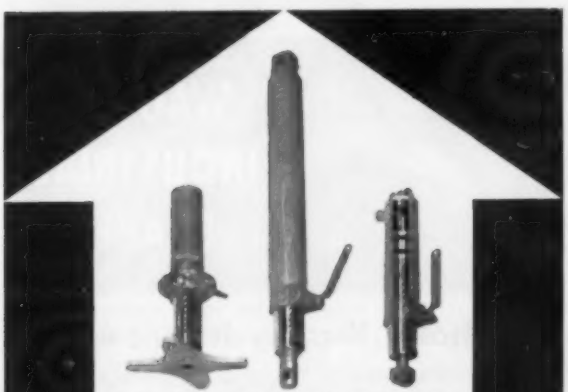
Clippard Miniature Air Valves (2 and 3-way), Cylinders (many types and strokes) and accessories can save air and money for YOU, and improve your tooling, jigs, fixtures and automated production devices, simply and inexpensively.

Write, NOW, for data-filled catalog and prices!

Clippard INSTRUMENT LABORATORY, INC.

7384-H Colerain Rd., Cincinnati 39, Ohio • Phone: JAckson 1-4261

Manufacturers of R. F. Coils, Electronic Equipment, Miniature Pneumatic Devices



CAT. NO. 562 CAT. NO. 1014 CAT. NO. 107

HYDRO-LATCH RAMS

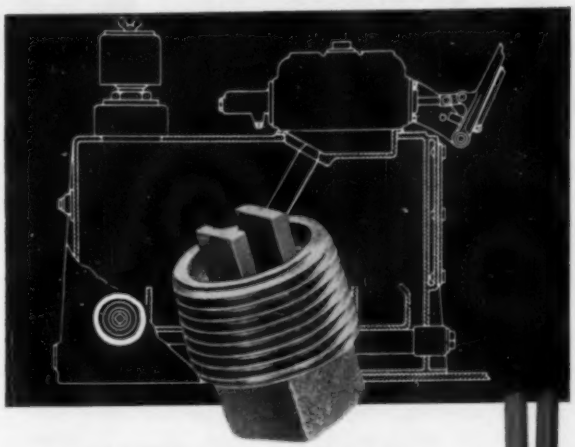
Single or double acting, tonnage capacity and length of travel to meet your specifications. Has spring loaded self-engaging latch as a safety factor, positive stop in case of hydraulic failure or to hold load for indefinite period. Clevis or Trunion mountings, manufactured of heat treated alloy steel, ram is polished and hard chrome plated with adjusting screw, ram end.

WILLIAM S. PINE

Custom Built Hydraulic Equipment and Hand Pumps

1635 E. 22nd St.
Los Angeles 11
Calif.

Prevent CLOGGING or FOULING of VALVES and PUMPS

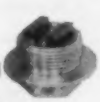


LISLE *Magnetic* PLUGS

Insure That Hydraulic Systems Will Work At Their Best

Controlled tests have proved that Lisle Magnetic Plugs installed in the flow path pick up abrasive ferrous particles and prevent them from interfering with the proper function of hydraulic systems. They guarantee longer life (up to 3 times) for pumps and other moving parts.

MANY TYPES AND STYLES TO CHOOSE FROM . . .



Lisle Corporation offers complete facilities for designing and manufacturing magnetic plugs for special installations.

Write for your free catalog and a sample Lisle magnetic plug for testing. Please state thread size.

LISLE *Corporation*

CLARINDA, IOWA

CIRCLE 101 ON READER SERVICE CARD

CIRCLE 86 ON READER SERVICE CARD

CIRCLE 130 ON READER SERVICE CARD

CIRCLE 48 ON READER SERVICE CARD

write for NEW **FREE** CATALOG

of Kendall— Governaire precision pneumatic

PRESSURE REGULATORS for Industry

The facts you need on a complete range of pneumatic pressure regulating valves and volume boosters. Here is your guide to a series of pilot-operated and direct acting regulators—in pipe sizes from ¼ to ⅜ and ¾ NPT...in supply pressures up to 250 psi. Fact-filled pages spell out the full story: characteristics • pressure ranges, ratios • applications—for 16 different models including motor operated and lever set types.

Write today for the new KENDALL- GOVERNAIRE catalog.

STRATOS

INDUSTRIAL PRODUCTS BRANCH

Route 109, West Babylon, N. Y.

A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION

Turbo-Expanders and Compressors
SPECON Variable Speed Drives and Transmissions
Pneumatic Pressure Regulators

GABB

FC-3500

TANK FILLER CAP

The Model FC-3500 is the first tank filler cap to successfully pass all test requirements of MIL-C-7244B (ASG) applicable to fuel, oil, alcohol-water and hydraulic reservoirs.

Lever action design permits cap to be opened safely under pressure and removed completely with only a 35° turn. Now available in 1.5, 2, 3, and 3.82″ openings.

Write for free literature.

GABB SPECIAL PRODUCTS Inc.
WINDSOR LOCKS, CONN.

Now . . . for the first time—

A FLUID POWER TRAINING PROGRAM

to fill industry's need for trained personnel

Hitchcock's NEW "job-related" home study course "INSTALLATION, OPERATION and MAINTENANCE of FLUID POWER EQUIPMENT

The problem of developing properly trained, qualified personnel to install, operate and maintain FLUID POWER EQUIPMENT becomes greater day by day. Design simplification and "advanced mechanization" continually expands and increases the uses of FLUID POWER to increase production and operating efficiency in all phases of industry.

Hitchcock Publishing collaborated with two of the nation's leading fluid power authorities to develop this program. Now, men can be trained "on-the-job" through home-study and daily direction in the development of practical skills in fluid power.

Hitchcock's course is available to company sponsored group enrollments or individuals on a low-cost basis in a convenient, practical 18 chapter study course. Upon completion of the course, students will attend a 2 day work-shop session for practical review, application and discussion of the material covered.

An up-to-date practical course of study covering Theory, Fundamentals of operation, Application, Diagnosis and Repair for all types of hydraulic and pneumatic equipment and controls.

Investigate **the advantages of Hitchcock's FLUID POWER home-study course for training individuals to fill your fluid power personnel needs. You'll benefit through increased production and operating efficiency. Send for complete information and enrollment forms today !**

HITCHCOCK Publishing Company / Dept. of Training & Education, Industrial Services Division, 222 E. WILLOW AVE., WHEATON, ILLINOIS

WAGNER INDUSTRIAL BRAKES

will "hold" that hydraulic winch

In fluid power applications, Wagner spring-applied hydraulic-released Industrial Brakes are finding increasing use for holding and stopping hydraulic motor drives. Special mineral oil or hydraulic brake fluid compatible parts and cast steel or malleable iron construction provide a brake to meet your needs. Wagner also supplies standard Actuating Systems for remote brake control.

Your Wagner Sales Engineer is backed by men with years of experience in braking and control system design. Let him help you solve your application problems. Write for Wagner Bulletin IU-226.

Wagner Electric Corporation

W150-2 6387 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

CIRCLE 65 ON READER SERVICE CARD

CIRCLE 143 ON READER SERVICE CARD

POST SCRIPTS OF INDUSTRY

The Sheffer Corporation named **F.P.C. Inc.,** 283 Grand street, Bridgeport, as sole distributors for its products in the state of Connecticut.

Lawrence Anderson, Jack Berg and **John Kerber** have been added to the **Commercial Filter Corporation's** Chicago sales staff, with headquarters at 6409 West North Ave., Oak Park. Anderson will serve as a special representative on OEM accounts and industrial sales.

Lawrence Anderson Commercial Filter

Daniel W. Ruple Titeflex, Inc.

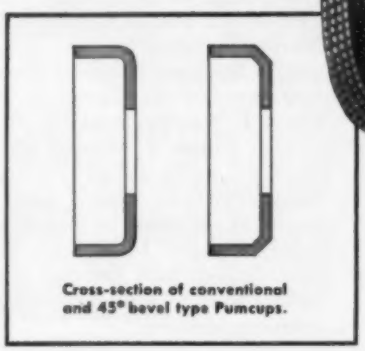
Daniel W. Ruple has been appointed assistant to the president of **Titeflex, Inc.,** a subsidiary of Atlas Corp. Ruple will function in a major staff capacity his primary responsibilities in the manufacturing divisions of Titeflex.

Theodore R. Ranney now heads the **Ranney Engineering Co.,** Chicago, Ill., founded by Willet R. Ranney, whose death was recently reported. The company will continue to represent Double A. Products Co., Gerotor May Corp., Rotac Division of Ex-Cello-O Corp., Hydro-Line Mfg. Co., Sperry Products Inc. and Kepner Products in the Chicago and northern Illinois area.

Quincy Compressor Company has opened new sales offices in Charlotte, North Carolina, Cincinnati, Ohio and has added to its Chicago office staff. **Bill Yoe,** in charge of the new sales branch in Charlotte, serves the N. Carolina,

Continued on page 164

2-way gain with PUMCUPS



Cross-section of conventional and 45° bevel type Pumcups.

Darcova Pumcups are available in various types and textures, in a complete range of sizes, to provide unequalled efficiency and long life in reciprocating pumps, air or hydraulic mechanisms.

★ prolonged high efficiency
★ less maintenance

TODAY hundreds of companies using hydraulic controls, air cylinders or reciprocating pumps are *standardizing* on Darcova Pumcups for piston packing, because they eliminate fluid slippage, costly down-time and maintenance.

Darcova Pumcups make the *most* of the cup packing principle. And, they are made in a complete range of sizes, types and texture-engineered compositions for various pressure-temperature-fluid conditions. Pumcups hold peak efficiency for the life of the cups and outlast other packing as much as 3 to 1.

Why not check these claims right in your own plant? Meanwhile get *all* the facts. Just send for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

CIRCLE 1 ON READER SERVICE CARD

only the **Fall** Gets it All!

WHY be satisfied with only partial removal of dirt or other foreign accumulation from piston rods when you can—

Remove ALL the Dirt from Rod O.D. Stop Dirt Passing Through the Ring Joint with a

Fall "CJ" WIPER RING

The Ring with a Closed Joint!
SPRING LOADED
with Squeeze Grip Action

If you have a wiper ring problem write, wire or phone us.

All Fall Rings are covered by patents issued or patents pending.

ACE PRODUCTS CO.,
Toledo 1, Ohio
Phone Cherry 3-6513

You Can Depend on ACE Products—Established 1935!

POST SCRIPTS OF INDUSTRY

S. Carolina, Virginia and Knoxville, Tenn., area. Operating out of Cincinnati; **Lawrence Wickliffe** will be active in southern Ohio, W. Virginia, Kentucky and the Nashville, Tenn. area. **Chuck Long** will represent the company in northern Indiana, northern Illinois and southern Wisconsin.

Albert J. Weatherhead, Jr., president of **The Weatherhead Company** announced these promotions and appointments: New plant manager in Cleveland is **Albert J. Weatherhead III.** He succeeds **Elmer J. Milnar,** who has been assigned to the St. Thomas, Ontario Canada plant. **James M. Mahon,** to manufacturing manager. **John Stair** to plant engineer. **Jack Smetzer** and **Laddie Rych** to positions in manufacturing research.

J. Frank Foster has been named president of **Vickers Incorporated,** a Division of the Sperry Rand Corporation. Foster also has been elected to the board of directors of Vickers. Foster joined the company as treasurer in 1941, was made vice president and assistant general manager in 1949 and early last year became executive vice president.

J. Frank Foster
Vickers Inc.

George W. Brooks
Greer Hydraulics

George W. Brooks has been named vice-president and general manager of **Greer Hydraulics Engineering, Inc.** west coast subsidiary of Greer Hydraulics, Inc. He will direct operations and supervise the enlargement of engineering at their North Hollywood, Calif. plant.

Will Not Powder
in Severest Service
—nor cut or stick to the shaft
because of temporary lubrication failure.

PROMET
ENGINEERED BRONZE BEARINGS
BUSHINGS
WEARING PARTS

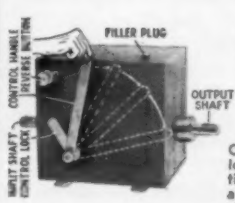
Write for literature and service data sheets, or send prints and condition of operation for recommendations and quotations.

Inquire about Promet Fully Machined CORED & SOLID BRONZE BAR STOCK—Saves time, tools and money.

THE American Crucible PRODUCTS CO.

1303 Oberlin Avenue — Lorain, Ohio, U. S. A.

• Original $200.00 Value •
1½ H.P. HYDRAULIC
SPEED REDUCER



Max. Input 750 R.P.M.
Min. Output 0 R.P.M.
Item # 115

Control lever locks in position to give accurate, constant, speed.

- Reversible—complete control both directions
- Automatic overload protection
- Adjustable torque 100-180 in. lbs.

Compact 7" x 8" x 7" Wght. 25 lbs.
Standard ⅝" input & output shafts.

FOR: REAMER DRIVERS
CONVEYORS
MIDGET CARS
GARDEN TRACTORS
F.O.B. CHICAGO—NOW ONLY $72.50

NEW SUMMER 1958 . . .
HYDRAULIC CATALOG
FREE!
FEATURING NEW AND SURPLUS
• Pumps • Valves • Cylinders
• Accumulators, Hose, Gauges, Fittings, All at Bargain Prices.
Immediate Delivery

GROBAN SUPPLY CO., Dept. AH-4
1139 So. Wabash Ave.
CHICAGO 5, ILL.

CIRCLE 152 ON READER SERVICE CARD

CIRCLE 58 ON READER SERVICE CARD

Racine Hydraulics and Machinery Inc., Racine, Wis. has named **Pearse-Pearson Co. Inc.** of Hartford, Conn., as their representative in the New England states.

Air-Flow Co., Inc., 1526 Grange Street, Philadelphia, Pa. will represent the **Galland-Henning NOPAK Division** in Philadelphia and surrounding territory. **F. J. Boni,** president of Air-Flow, has had many years experience in the sale and application of hydraulic and pneumatic equipment.

The American Bosch Arma Corp., Springfield, Mass. has named **Fluid Mechanics Inc.,** Cleveland, Ohio, distributor for their line of hydraulic starters and accumulators.

U.S. Gauge Division, American Machine and Metals, Inc., appointed **Robert V. Dallis** as manager of the company's Atlanta, Georgia office. **Met-Tric Control Company,** 113 South Brevard Street, Charlotte, North Carolina, was named a master stock distributor for USG products in that area.

Waterman Engineering Co., Evanston, Ill. announced the appointment of **Edward E. Braun** as sales manager, industrial division, and **Harry A. Hedland** as sales manager, aircraft division.

Harry A. Hedland
Waterman Engr. Co.

Edward E. Braun
Waterman Engr. Co.

Parker-Hannifin Corp., Cleveland, Ohio announced it will unite its **Parker Rubber Div.** and **Franklin C. Wolfe Div.** into one organization. The name of the new division will be, **Parker Seal Co., Division of Parker-Hannifin Corp.**

CIRCLE 126 ON READER SERVICE CARD

IMMEDIATE DELIVERY

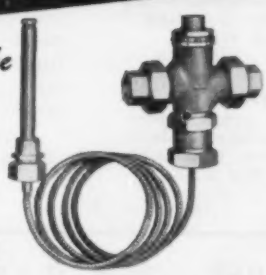
contour cutters for popular hydraulic ports!

One pass completes all operations necessary to produce the port contour. Job time cut as much as 3/5! All have carbide cutting edges for long life, smooth finishes. Available in all sizes. Write for prices.

SONNET
Tool and Mfg. Co.
576 North Prairie Avenue
Hawthorne
California

If your equipment or process requires . . .
ACCURATE, AUTOMATIC TEMPERATURE CONTROL
for HEATING or COOLING (using STEAM, WATER, or HEAT TRANSFER FLUIDS)

There is no equal to the
Sterlco®
Series 150-E
TEMPERATURE CONTROL VALVE

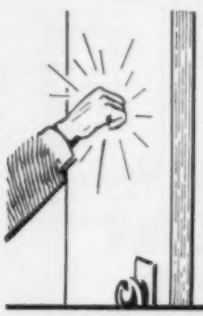


Here is a quality, dependable, and low cost self-actuated automatic modulating control valve. It's compact, self-contained; and, as part of your equipment or process, will eliminate the human factor of manual valves. Balanced single-seated construction eliminates effect of pressure variation. Send for Bulletin #505.

MOUNTS *and* OPERATES *in* ANY POSITION

INDUSTRIAL CONTROL DIVISION
STERLING, INC.
5202 W. Clinton Ave. • Milwaukee 18, Wis.

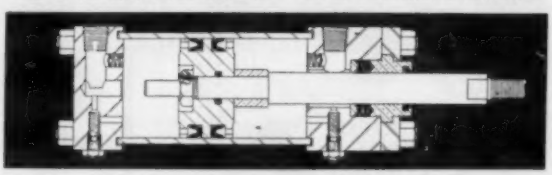
CIRCLE 128 ON READER SERVICE CARD



KNOCK ON ANY DOOR

and users will tell you about the superior qualities of

LYNAIR AIR and HYDRAULIC CYLINDERS



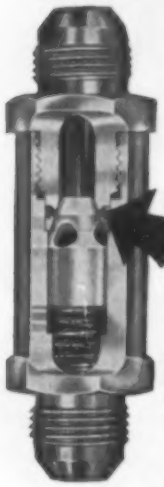
Pictured is the new Series-A AIR CYLINDER, an outstanding addition to the popular Lynair line . . . A complete range of sizes . . . Cylinders meet JIC standards . . . Airdraulic Cylinders for the action of hydraulic cylinders using air pressure.

Write today for detailed catalog.

LYNAIR, Inc. 3100 E. MICHIGAN AVE. JACKSON, MICHIGAN

CIRCLE 88 ON READER SERVICE CARD

CIRCLE 78 ON READER SERVICE CARD



Simple, Secure
. . . Leak-Tight!
this
FLEXIBLE
SEAL
SEAT*

Here's the secret . . . responsive action of the soft, long-lasting O-ring seal! Instantly compresses to seal internal and external pressures. Draws harmlessly around dirt particles. No costly precision parts or extra end seals. Six standard Dryseal pipe and JIC tube sizes; 12 connection combinations. Send for data sheet.

KEPNER PRODUCTS COMPANY
7321 West 59th Street • Summit, Illinois

Kep-O-seal

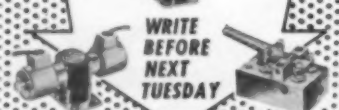
HYDRAULIC & PNEUMATIC
CHECK VALVES

* PATENT APPLIED FOR

ALLEN AIR
VALVES

Technical catalog (with prices listed) — yours for the asking.

WRITE BEFORE NEXT TUESDAY



The A. K. ALLEN CO. AH-4-V
255 East 2nd St., Mineola, N. Y.

Name .....
Company .....
Address .....
City ..... Zone ..... State .....

THE MARKET PLACE

When replying to a box number in the Market Place, address your letter to Applied Hydraulics, 812 Huron Road, Cleveland 15, Ohio. Attention: Box No.

WEST COAST SALES ENGINEER HYDRAULICS

Opening for top flight experienced man. Protected territory is one of our most productive on the West Coast. M. E. background required. Must be self-starter and able to work with high level engineering-purchasing contacts in all industries, including missile and atomic energy. Our company is the largest and fastest growing distributor of components, covering six West Coast states, with offices in Los Angeles, Oakland, Portland and Seattle. A fifteen-man Engineering Department, and a thirty-man Shop backs up field men for the design and manufacture of Hydraulic Systems and Machinery. Top compensation includes substantial salary, plus commissions, profit sharing plan, and company-paid health and welfare. Will assist with relocating costs. Your resume will be handled in strict confidence. Eastern interviews arranged.

Telephone No.-Olympic 3-5221 — Collect — C. J. Woodward, V. P.
The Rucker Company
P. O. Box 8158
Oakland, California

SOUTHERN CALIFORNIA SALES ENGINEER PNEUMATICS

Outstanding opportunity for experienced salesman with proven sales record in air valves, cylinders and controls. Protected territory backed by top lines and large stocks. Excellent compensation, plus commissions, profit sharing plan, and company-paid health and welfare. Will assist with relocating costs. Your resume held in strict confidence. Eastern interviews arranged.

C. J. Woodward, V. P.
The Rucker Company
P. O. Box 8158
Oakland, California

POSITION WANTED

Pump engineer, 15 years experience in high performance piston type pumps, desires responsible position. Write to Box 4258, APPLIED HYDRAULICS.

WANTED — BY PURCHASE OR MERGER

We are interested in acquiring a proven non-defense, proprietary item with $100,000 monthly volume. Prefer fluid handling and/or control devices; hydraulic or pneumatic valves. Careful consideration will be given your proposition. Contact me personally,

C. T. Keith, Vice President
Aero Supply Mfg. Co. Inc.
Corry, Pennsylvania
Telephone: Corry 2-8261

HYDRAULIC ENGINEER

Desires responsible position in design and development of hydraulic systems. Graduate engineer with 8 years experience. Prefer Pittsburgh area. $10,000 minimum. Write to Box 4158, APPLIED HYDRAULICS.

PROJECT ENGINEER

With 10 years experience in design, development and testing of hydraulic and pneumatic components. Specialist on seals for use in aircraft and industrial fluid power systems. Detailed resume on request. Write to Box 4358, APPLIED HYDRAULICS.

WANTED SALES MANAGER— SALESMEN

This company with AAA-1 Rating is screening applicants for position of Sales Manager and Salesmen to direct and sell a line of hydraulic pumps, cylinders, and valves to Industrial OEM's. Unusual opportunity for ambitious, creative performers. Engineering background desirable, but not mandatory. Please send complete resume of past performance. All replies held strictly confidential. Our employees know of this ad.

THE PERFECTION
STEEL BODY COMPANY
GALION, OHIO

In 1958
will you buy . . .

. . . a mink for the wife?
. . . a piano for the kids?
. . . a vacation in Hawaii?

If it's only money that's stopping you, find out how you can get a part of the $1200 APPLIED HYDRAULICS will award winners of the 1958 Prize Paper Contest.

To get complete information Circle 240 on Reader Service Card

ADVERTISERS' INDEX
APRIL 1958

A

Ace Products Company 164
Aeroquip Corporation 21
Afco Fitting Company 107
Air-Maze Corporation 123
Air-Mite Devices, Inc. 155
Alroyal Company 141
Ajax Flexible Coupling Co. 48
Alemite Division, Stewart Warner Corporation 17
A. K. Allen Company 166
American Cast Iron Pipe Company 66
American Crucible Products 164
American Engineering Co. 4
Anchor Coupling Company, Inc. 5
Geo. Angus & Co. Ltd. 58
Armite Laboratories 157
Arrow Tools, Inc. 122
Automatic Switch Company 119

B

Babcock & Wilcox Company
Tubular Products Division 8
Barco Manufacturing Co. 98
Barksdale Valves ..... Cover 3
Beckett-Harcum Company 108
Behlen Manufacturing Company 105
Bell & Gossett Company 168
Bellows Company 19
Benton Harbor Engineering Works 154
Berry Hydraulics 25
British Ermeto Corp. Ltd. 146
Bruning Company 46

C

Capital Engineering & Mfg. Corp. 151
Cardwell Machine Company 144
Chicago Rawhide Manufacturing Co. 51
Clippard Instrument Laboratory, Inc. 101
Columbia Steel & Shafting Co.
Summerill Stainless Tube Division 113
Commercial Filters Corporation 70
Commercial Shearing & Stamping Co. 95
Crane Packing Company 56
Cross Manufacturing Company 150

D

Darling Valve & Manufacturing Company 163
Denison Engineering Division
American Brake Shoe Company 72
Dynex, Incorporated 115

E

Eastern Industries, Inc. 129
Eastman Manufacturing Company 12

F

Flexonics Corporation 142, 143
Flodar Corporation 103
Fluid Controls, Incorporated 148
Foster Manufacturing Company, Inc. 149
Fulflo Specialties Company, Inc. 62

G

Gabb Special Products Inc. 162
Galland-Henning Manufacturing Co.
Nopak Division 7
Garlock Packing Company 101
Gast Manufacturing Corporation 141
General Controls Corp. 31
Gits Bros. Manufacturing Company 41
Graton & Knight Co., Inc. 150
Greenlee Tool Company 147
Greer Hydraulics, Inc. 97
Gresen Manufacturing Company 146
Groban Supply Company 164

H

Halogen Insulator & Seal Corp. 43
Hanna Engineering Works 1
Hannifin Company
Division of Parker-Hannifin Corp. 111
Hansen Manufacturing Company ..... Cover 2
Haskel Engineering & Supply Company 136
Helicoid Gage Division
American Chain & Cable Company 24
Hitchcock Publishing Company 162
Hoke, Incorporated 98
E. F. Houghton & Company 14, 15
C. B. Hunt & Son, Inc. 16
Hydraulic Accessories Company 157
Hydraulic Power Division
Hydraulic Press Manufacturing Co. 140
Hydraulic Unit Specialties Company 155
Hydraulics & Pneumatics Ltd. 167

I

Imperial Brass Mfg. Company 64, 65
International Packings Corp. 99

J

Johns-Manville 47

K

Keelavite Rotary Pumps & Motors Ltd. 67

CIRCLE 99 ON READER SERVICE CARD

SAVE WORLD'S LARGEST ON-THE-SHELF STOCK OF HYDRAULICS

NEW PALLEY HYDRAULIC CYLINDERS
Shown here are two types of our newly developed lines of Hydraulic Cylinders. These Cylinders are designed to meet the most rigid requirements of Industry. All are double action with rugged steel construction. Type (B) is a flange mounted, Press Type which delivers up to 21,000 lbs. thrust at 3000 PSI. Type (A) is a heavy duty, external cap cylinder which ranges up to a thrust of 37,500 lbs.

B AS LOW AS 56.95

A 36.00 AND UP

For complete listing of our prices & tremendous stocks send for Catalog below.

NEW 4-WAY – SLIDING PISTON HYDRAULIC VALVE
A newly developed valve which can be connected in series to operate two or more Hyd. Cylinders, independently or in unison. Has built-in relief valve, adjustable from 1200 to 3000 PSI. Max. flow 10 GPM. Available in 2000 PSI at $24.50 or 3000 PSI at $32.75.

WORLD'S MOST AMAZING CATALOG

NATIONALLY ADVERTISED MERCHANDISE NEW and USED GOV'T SURPLUS

396 PAGES

This catalog features the Largest Stock of Hydraulic Equipment and Supplies ever seen under one roof! This includes our own line of Hydraulic Cylinders as well as over 50,000 Gov't Surplus Cylinders. Also Hyd. Valves, Pumps, Motors, Tubing, Hardware, Plumbing, etc. plus a complete stock of Electric Motors, Power Tools, Plant & Office Equip., etc. Send for Your Copy Today and Save!

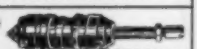
GOV'T SURPLUS BUYS

VICKERS HYDRAULIC ANGLE PUMPS
Made to top aircraft specs.

Cat. No.	GPM	PSI	RPM	Price
H-P4A	5.3	1000	3000	$22.50*
H-P5A	2.7	1500	3000	25.75*
H-P4U	6	1000	3000	22.50*

*Used but excellent condition.

2000 PSI HYDRAULIC CYLINDER SPECIAL Only 12.75

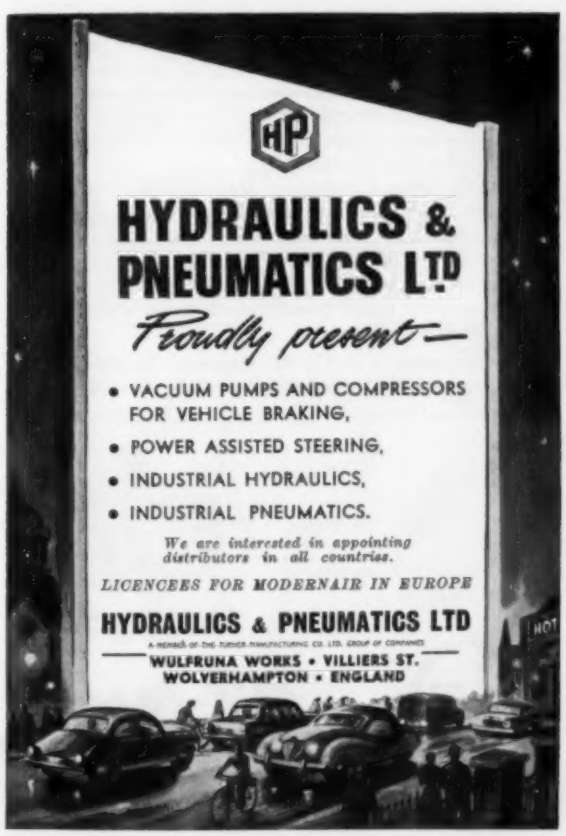


Genuine top quality Gov't Surplus. Used but excellent condition. Has a Bore of 2-1/4", Shaft 1", Stroke 4". Eye-to-eye lgth. 13½". Parts 1/4" AN.

TERMS: Send Check, Cash or Money Order. 50% Deposit with C.O.D.s. Prices F.O.B. Los Angeles, Calif. Warehouse.

Palley's

2263 E. Vernon Ave., DEPT. AH-48
Los Angeles 58, California

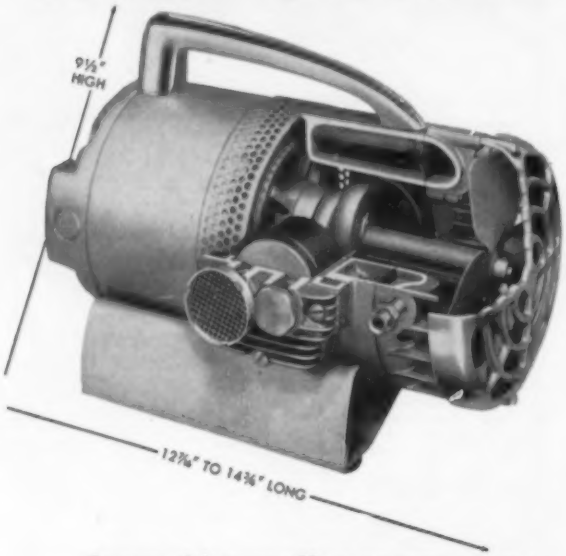

HP
HYDRAULICS & PNEUMATICS LTD
Proudly present—
• VACUUM PUMPS AND COMPRESSORS FOR VEHICLE BRAKING,
• POWER ASSISTED STEERING,
• INDUSTRIAL HYDRAULICS,
• INDUSTRIAL PNEUMATICS.
We are interested in appointing distributors in all countries.
LICENCEES FOR MODERNAIR IN EUROPE
HYDRAULICS & PNEUMATICS LTD
A MEMBER OF THE TURNER MANUFACTURING CO. LTD. GROUP OF COMPANIES
WULFRUNA WORKS • VILLIERS ST.
WOLVERHAMPTON • ENGLAND
HOT

CIRCLE 72 ON READER SERVICE CARD

Cleaner...Drier...Cooler

Oil-Free

COMPRESSED AIR



...from this smaller compressor

No more oil-spoiled work...there's not a drop of oil in this new design, compact, lightweight unit! Motor and compressor are permanently grease-packed...graphite piston rings and skirts operate for years without destroying the mirror finish of the cylinder walls. Since the cylinders are not lubricated, oil-free air is delivered at all times, without need for an oil separator.

B&G Oil-less Compressors are really *smooth!* Modern design, large bore, short stroke, horizontally opposed pistons provide better balance and vibrationless operation. No lubrication of any kind required—no expensive lubrication maintenance. B&G Compressors are available in a complete line of portable, tank-mounted and tankless models.

Capacities: ¼ to 1½ HP. Pressures: To 190 psi. Vacuum: 27.5". Air displacement: To 13.14 CFM.

For complete information send for Catalog GO-1156.

B&G Compressor built into dry cleaning machine.

Compact, light weight B&G Compressor is easily carried.

Oil-less AIR COMPRESSORS

BELL & GOSSETT COMPANY

Dept. FF-66, Morton Grove, Illinois

Kapner Products 166
Walter Kidde & Company, Inc. 124
Kistler Instrument Corp. 139
Koppers Company, Inc.
Piston Ring & Seal Dept. 20
Kunkle Valve Company 141

L

L & L Manufacturing Company 112
Linde Company
Division of Union Carbide Corp. 133
Linear, Inc. 52
Lisle Corporation 161
Lovejoy Flexible Coupling Co. 160
Lynair, Incorporated 165

M

Marsh, C. W. Corporation 26
Jas. P. Marsh Corporation 157
Marvel Engineering Company 75
M-B Products Division
Tool Sales Company 149
Mead Specialties Company 157
Mechanical Air Controls 22, 23
Miller Fluid Power Division
Flick-Reedy Corporation 33, 34, 35
Minnesota Rubber Company 2

N

National Seal Division
Federal-Mogul-Bower Bearings, Inc. 109
Wm. W. Nugent & Co., Inc. 18

O

The Oilgear Company 11
Ortman-Miller Machine Company, Inc. 148

P

Palley Supply Company 167
Pathon Manufacturing Company 121
William S. Pine 161
Pioneer Oilsealing & Moulding Co. Ltd. 44
Plastic & Rubber Products Company 131
Pneu-Trol Devices, Inc. 145
Polymer Corporation 54
Purolator Products, Inc. 135

Q

Quincy Compressor Company 159

R

Raybestos Manhattan, Inc.
Packing Division 152, 153
Republic Manufacturing Company 123
Republic Steel Corporation 73
M. H. Rhodes, Inc. 123
Rivett Incorporated 117
Rochester Manufacturing Co. 63
Rosaen Company 158
Rotherm Engineering Co. Inc. 155

S

Sanders Associates, Inc. 28
Sarasota Precision Products 150
Thomas Savery Pumps Ltd. 149
Sealol Corporation 158
Sheffer Corporation 145
Shell Oil Company 45
Shenango Furnace Company
Centrifugally Cast Products Division 40
Simplex Engineering Company 53
Sinclair-Collins Valve Company 42
Snap-Tite, Inc. 69
Sonnet Tool & Manufacturing Company 165
Star Jack Company, Inc. 146
Sterling, Incorporated 146
Stratoflex, Inc. 156
Stratos Division
Fairchild Engine & Airplane Corp. 162
Summerill Stainless Tube Division
Columbia Steel & Shafting Co. 113
Sun Oil Company 57

T

Texas Company 76
Titeflex, Inc. 60, 61
Tomkins-Johnson Company 49
Tru-Seal Division
Flick-Reedy Corporation 149
Tube Reducing Corporation 30
Tuthill Pump Company 27
Union Carbide Corporation
Linde Company 133
United Metallic "O" Ring Corp. Div. of
United Aircraft Products, Inc. 139
U. S. Gasket Company
Plastics Division of The Garlock Packing Co. 137

V

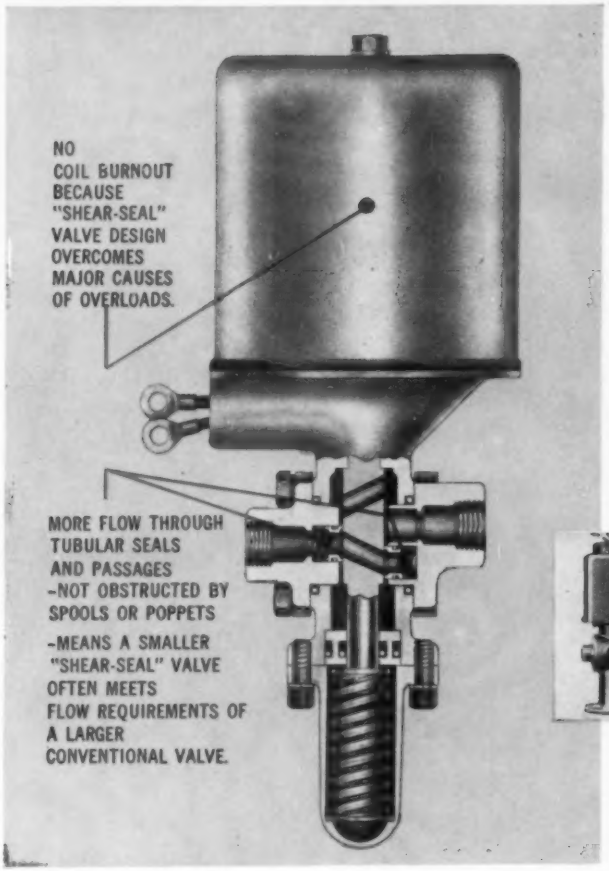
Valvair, Inc. 10
Vickers, Inc.
Division of Sperry Rand Corporation 55
Victor Equipment Company 71

W

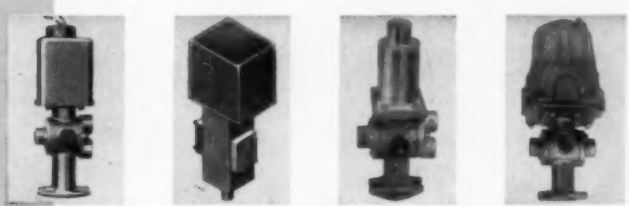
Wagner Electric Corporation 162
Waterman Engineering Company 13
Watts Regulator Company 29
Webster Electric Company 9
Westinghouse Air Brake Company
Industrial Products Division 59
Wilkerson Corporation 145
Wooster Division
Borg-Warner Corporation 39

LEAKPROOF at 3000 P.S.I.

stop creeping cylinders!



STANDARD WHEREVER CLOSE LEAKAGE SPECIFICATIONS ARE VITAL: On hydraulic clamps of paper cutters, in propeller pitch control for ships, to lift rollers over seams in textile printing, in rocket charging, in nitrogen and freon charging (refrigeration coils, pressure bottle charging of insecticides and shave cream), as high pressure cut in on presses, on soaking pit doors and lift tables in steel mills, for airblast control on copper converters, on oil well blowout preventers, in test board applications, wherever a valve must be leakproof and stay leakproof.

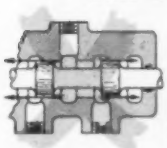


250 P.S.I., 1000 P.S.I. and 1500 P.S.I. Air Valves; 250 P.S.I., 1500 P.S.I. and 3000 P.S.I. Oil and Water Valves; for A.C. and D.C. operation, Standard and Explosion-proof; Shut-off, Three-way, Four-way and diverter flow patterns.

NO STICKING

because the movement of the sealing members does not depend on lubrication, the direct acting solenoid maintains a positive power margin.

This is why we don't use



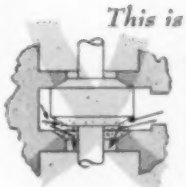
SPOOL VALVE DESIGN

They depend on leakage for lubrication, dirt can enter spool clearance, cause binding and coil burnout.

LONG, MAINTENANCE-FREE SERVICE

is assured through the lapping action of the Shear-Seals against the slide, which actually improves the sealing qualities of the valve with each operation. The small amount lapped from the Shear-Seals after millions of cycles is compensated by a back-up spring. Dirt or pipe scale cause no damage or failure because the spring keeps the sealing surfaces in constant intimate contact.

This is why we don't use



POPPET VALVE DESIGN

Dirt in fluid passes over sealing surfaces, acts like a sand blast quickly destroying sealing qualities.

Write for Catalog 58-59

barksdale valves CONTROL VALVE DIVISION

5125 ALCOA AVENUE • LOS ANGELES 58, CALIFORNIA

CIRCLE 19 ON READER SERVICE CARD

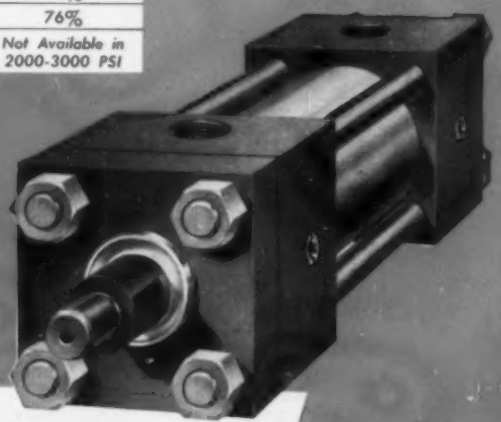
Save 27% or more in cost...

NEW Miller "JOB RATED" HYDRAULIC CYLINDER LINE

JOB RATED, MODEL " J "

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

*with **IDENTICAL** seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.*



SEAL FAILURE MEANS CYLINDER FAILURE!

1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage **because** Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

TEFLON SHEF SEAL At Tubing Ends

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON Seals On Piston Rod And Bushing

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON Seals On Ball Check And Adjusting Screw

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

MILLER Uses Resin-Impregnated Leather Piston Cup Seals **because** they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

2. *Nicked or scored piston rods cause seal failure.*

MILLER Uses Case-Hardened Chrome-Plated Piston Rods **because** they prevent nicks, scoring and rust.

Visit Our
BOOTH #839,
Design Engineering Show, April 14-17, Chicago Amphitheatre,
& BOOTH #1625,
A.S.T.E. Show, Philadelphia, May 1-8.

NOW! . . . You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

*du Pont trademark for tetrafluoroethylene resin which withstands temperatures from −100° F. to +500° F. and all hydraulic fluids.

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES
- Rust-Resistant Surfaces
- Interchangeable, Space-Saving Square, 4-Tie-Rod Design
- Precision Honed Barrels

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION
2008 N. Hawthorne Ave., Melrose Park, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS